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Plastics

DEALING WITH THE MANUFACTURE, USES AND POTENTIALITIES OF PLASTIC MATERIALS

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DETROIT

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That way you make sure of getting **precisely** the polystyrene you want. Kleestron make a comprehensive range of general polystyrenes and impact materials—and will gladly supply technical details, prices, etc.

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Extrusions unlimited!

A complete range of sections and materials for a variety of applications

Erinoid Limited are prepared to develop extrusions for Industry from rough drawings to mass production. With our Laboratory Technicians and skilled engineers we have a team which will find an answer to the most intricate extrusions in P.V.C. (rigid and flexible), Cellulose Acetate, Polystyrene, Acrylic Nylon, etc.

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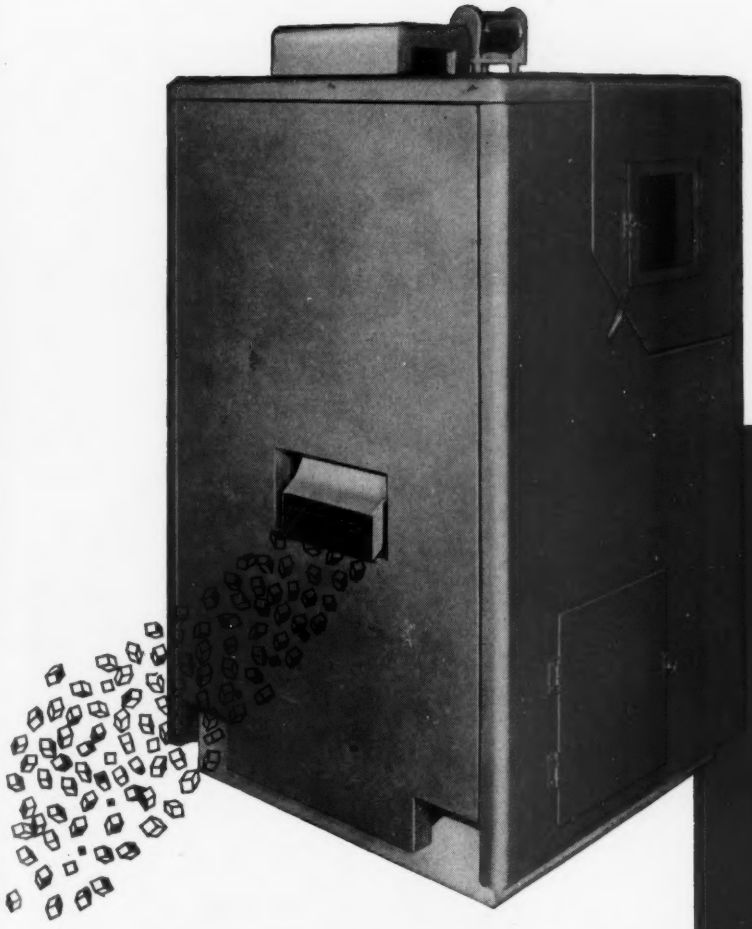
West Halkin House, West Halkin Street, Belgrave Square, London, S.W.1.

THIS IS NEWS

THE NEW **BURTONWOOD-CUMBERLAND**

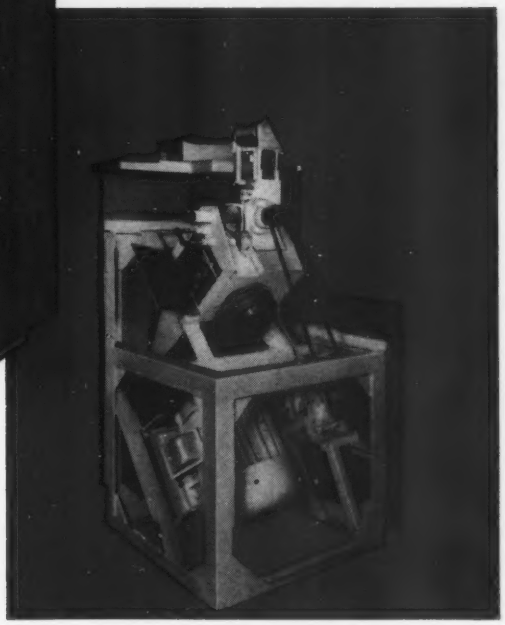
3½" Vertical Stair-Step Dicer



The latest edition to the range of Dicers, Pelletizers and Granulators.

A smaller version of the highly successful Burtonwood-Cumberland Dicer, this new machine has vertical feed, which eliminates drag, with soft or warm materials, and gives perfect control over pellet production with excellent high output rates for the full range of plastic materials.

This standard machine is fitted with an 8-knife Rotor, and is capable of cutting $\frac{1}{16}$ in. to $\frac{1}{2}$ in. cubes by simply changing the knives.



The outer cover of the machine is fitted as standard equipment and has an acoustic lining.

Write for complete technical details.

Gives closer control over feed rate and pellet size.

Manufactured under licence from Cumberland Engineering Co. Inc., United States.

BURTONWOOD ENGINEERING CO. LTD.

Head Office and Works: Burtonwood, Warrington, Lancashire. Telephone: Newton-le-Willows 3311 (10 lines).

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Samples and further particulars will be gladly supplied on application to our Technical Sales Department.

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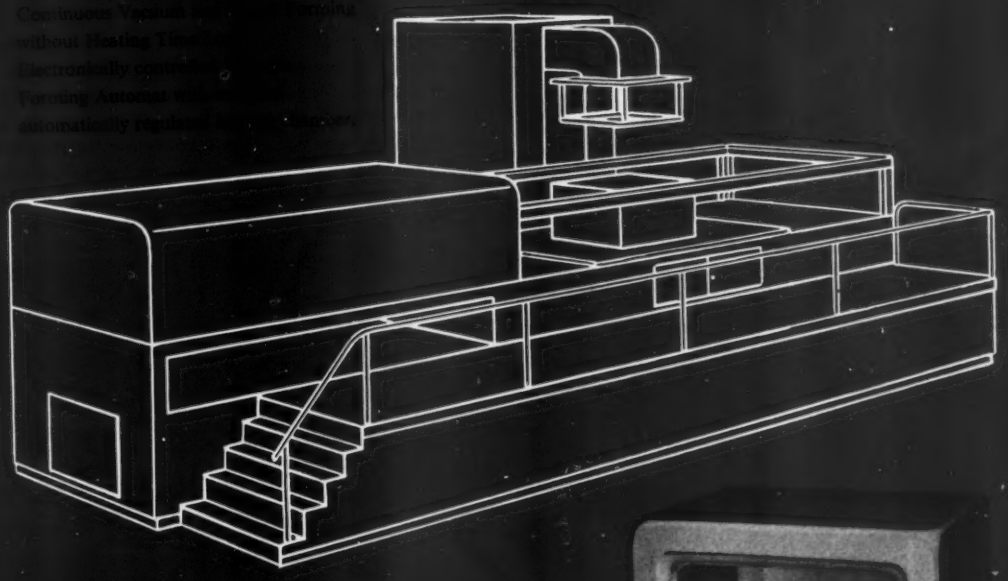
PLASTIPLAST

58 MA
"Contraform"

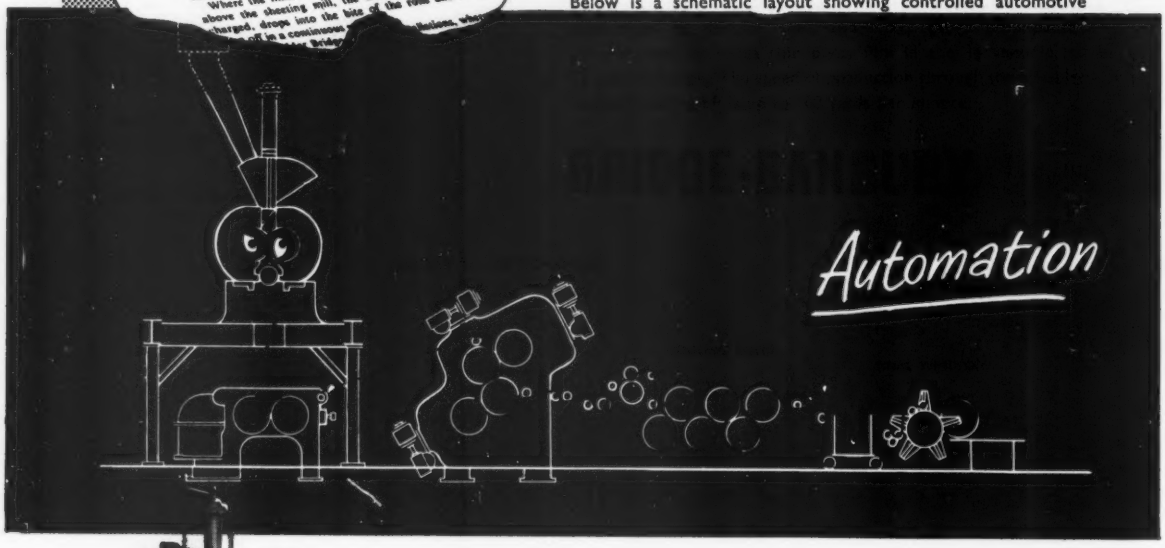


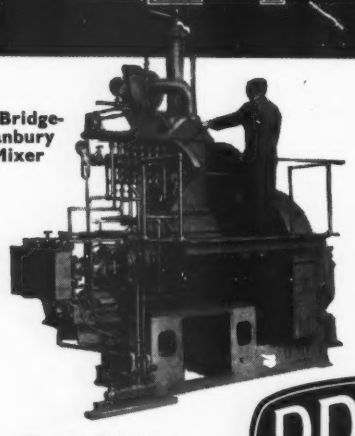
Vogt and Hartmann

You can call this a FELINE QUADRUPED

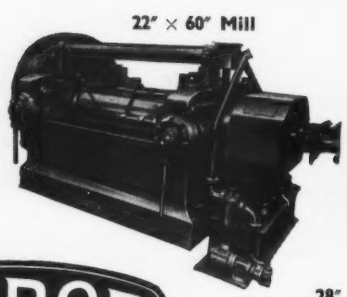
20
INSTALLATION AND OPERATI
many years, the company has made a speciality of engineering complete processing set-ups. Developed from start to finish by company engineers, each of these layouts is composed of production machines matched in capacity to prevent 'he "choking" or "starving" of succeeding units. Production flows without costly interruptions and with manual aid and supervision reduced to a minimum.
Where the mixer is located on a mezzanine directly above the sheeting mill, the mixed stock, when discharged, drops into the bite of the rolls and can be

We know it as a cat. You can refer to a highly efficient continuous production method as "automation". We know it as a system which we have recommended and applied all along to our BRIDGE-BANBURY Matched Production Processing Units. On the left is a reproduction of a portion of our catalogue published a long time before the word "automation" became so popular. Proof indeed that what is now hailed as the ultimate in efficiency has in fact been available to BRIDGE-BANBURY users for years. Below is a schematic layout showing controlled automotive

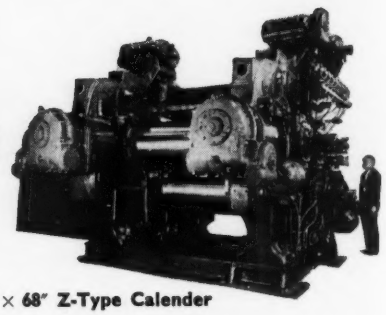




3A Bridge-Banbury Mixer



22″ × 60″ Mill



28″ × 68″ Z-Type Calender

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- *Higher resistance to heat — satisfactory up to sterilisation temperatures.*
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Here is an important new plastic for stronger, tougher products, products in greater variety, products with longer working life. *It opens up new production vistas, especially in the fields of domestic and industrial ware, in piping and fittings, in bottles and containers.* Shell Service Laboratories and technical staff are ready to give the closest co-operation in product and process development.

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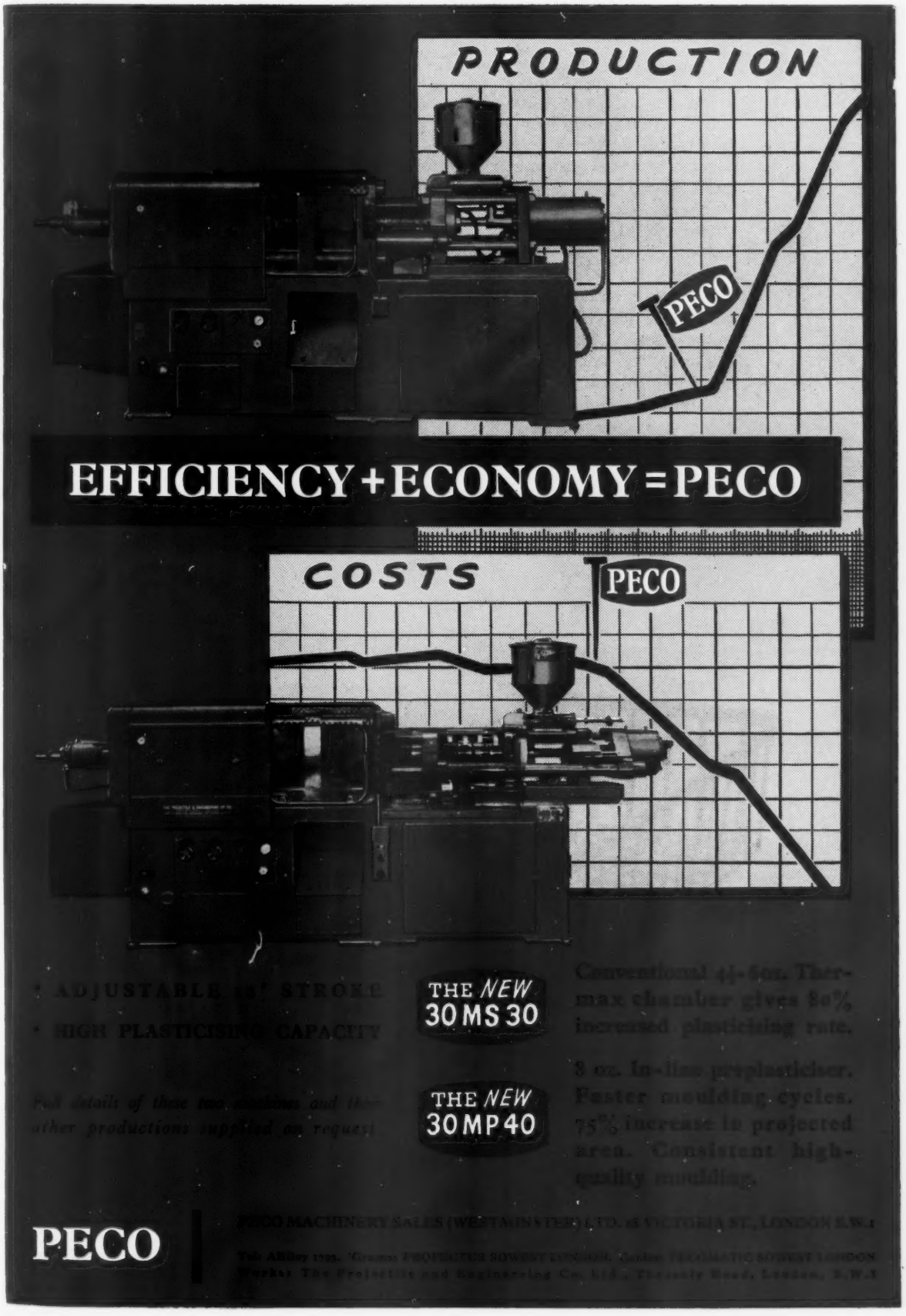
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The punnet is moulded in Erinoid CP.15. It has an average wall thickness of 0.030 in. Although the maximum distance of flow from the gate is approximately 8 in., these articles are moulded at an overall cycle of 5½ seconds. Erinoid CP.15, which is complementary to CP.20 high impact polystyrene, is a new grade of impact polystyrene with exceptional flow properties. CP.15 is the answer for any moulding which requires strength and high gloss and yet has to be produced on moulds where it is difficult to maintain high temperatures.

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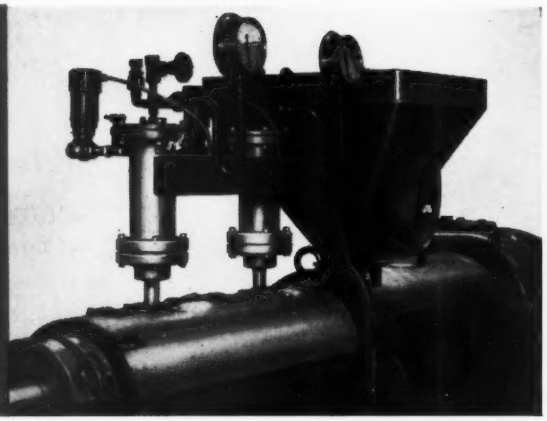
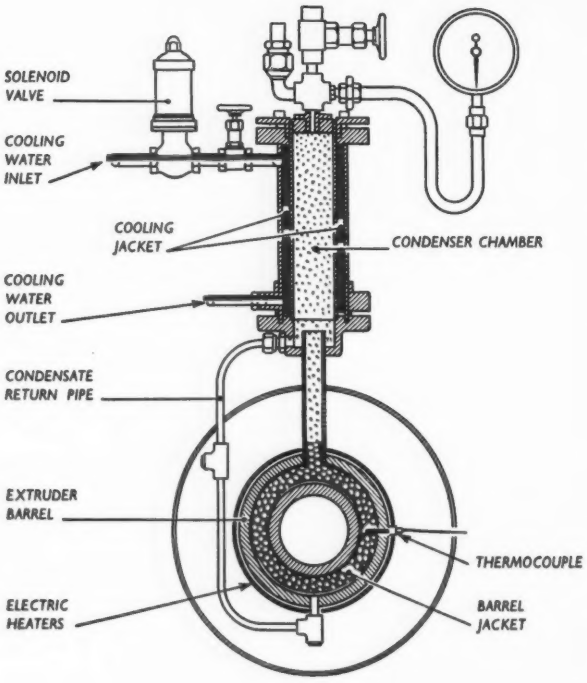
Willert *Patent*

VAPOUR Cooling System





Section through extruder barrel and condenser unit

more *efficient* cooling at *lower* capital cost

In this system, the latent heat of the vapour in the condenser chamber (*dotted red in diagram*) is extracted by automatically passing coolant through the condenser jacket (*solid red*) when the barrel temperature exceeds that set on the electronic controller. Cooling is thus achieved in the most ***efficient*** possible way, and ***at the operating temperature.***

Vapour cooling gives ***accurate control*** of barrel and melt temperatures.

Since the cooling takes place outside the barrel, there is no thermal shock or the setting up of temperature gradients within the zones whilst cooling. The fluid also acts as a temperature equaliser around the barrel when the electric heaters are functioning.

Vapour cooling is valuable in reducing the plastic melt temperature when operating at high screw speeds under near adiabatic conditions. This is of particular advantage with heat sensitive polymers, and where output is limited by the fluidity of the extrudate. For ***polythene*** and ***P.V.C.*** distilled water is used in the jacket, and since all the internal surfaces are machined, a ***high heat transfer coefficient*** is maintained. The maximum temperature at which the vapour cooling system will operate efficiently is unlimited since different fluids can be used in the system to cover different ranges of temperature.

The Willert Vapour Cooling System has all the advantages of using steam or oil for heating and cooling the barrel, ***without the high capital cost*** of these two methods. It is also ***cleaner*** and ***requires only a fraction of the space.***

Improved temperature control by means of the Willert Vapour Cooling System means higher output and improved dimensional control of your extruded products.

Extrusion Equipment

Made under licence from
FRANK W. EGAN & COMPANY
NEW JERSEY, U.S.A.

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see Monsanto first!

Monsanto Polyethylene is manufactured by the high pressure process. It is produced in a wide range of grades, suitable for:

Extrusion — Film and lamination
Wire and cable coating
Tubing

Moulding — Injection moulding
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In association with: Monsanto Chemical Company, St. Louis, U.S.A. Monsanto Canada Limited, Montreal. Monsanto Chemicals (Australia) Limited, Melbourne. Monsanto Chemicals of India Private Limited, Bombay. Representatives in the world's principal cities.

"But why Powermaster?"

" Tell me, Bill, why are you so keen on a Powermaster Packaged boiler? After all there are other makes, you know!"

" Well, there are three things I look for when I buy a boiler. First, has it been completely proved in operation? Second, does it really do what the makers say it will? And finally, as the engineer responsible for running it, can I get prompt and efficient service whenever I need it? "

" Does the Powermaster do all that?"

" It certainly does. I happen to know that I.C.I., Goodyear, Unilever and a lot of other big people use Powermaster. In fact, the G.W.B. engineer told me that over 400 are now in use in this country."

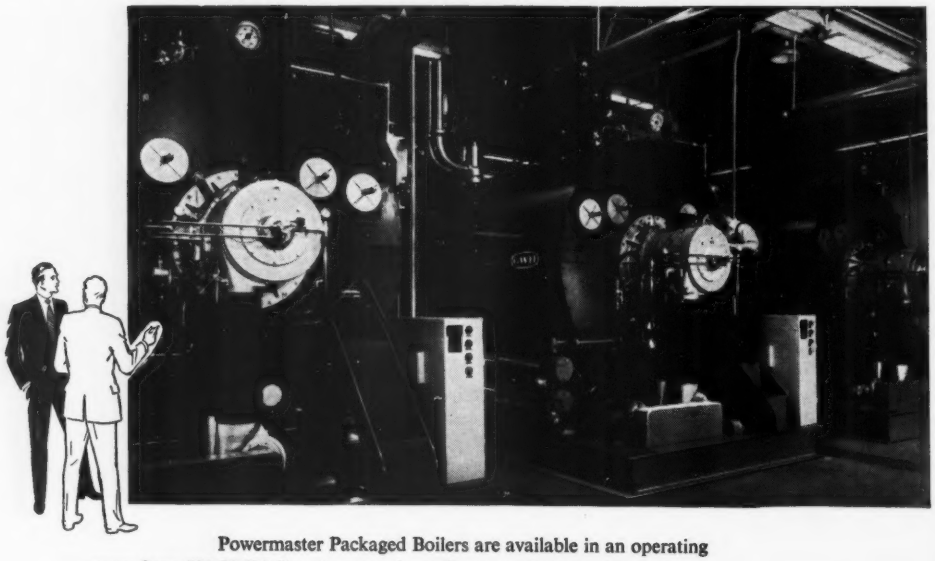
"Right. What about performance?"

"Every Powermaster, whatever its size, operates at a guaranteed efficiency of over 80% from approximately 20-100% capacity. Incidentally, the Voriflow burner is one of the finest I've seen."

"I'm no engineer so I'll have to take your word for that. But what about this after-sales service you're so keen on?"

"That's the main reason I prefer a Powermaster. If we install a Powermaster we'll get an established service organisation, every member of which has been trained in the G.W.B. factory. Packaged Boilers are quite a specialised field of engineering and G.W.B. have had more experience than anyone else in this country. Simple enough!"

" Well, Bill, you sound a bit like an advertisement, but you've convinced me!"



Powermaster Packaged Boilers are available in an operating range from 500-20,700 lbs. steam per hour. Every modulating Powermaster, regardless of its size, operates at a guaranteed efficiency of over 80% on 20-100% capacity. Simple installation, easy maintenance, rapid start-up, and smokeless operation—all combine to make the Powermaster the most successful Packaged Automatic oil-fired Boiler in the world. Please write for details.

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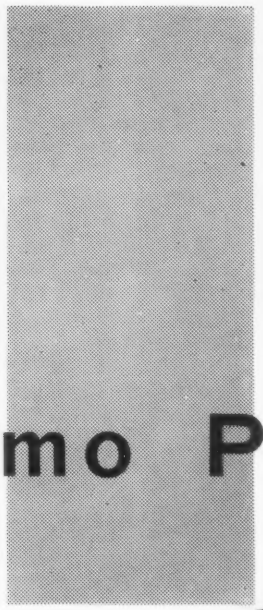

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MOULDERS AND FABRICATORS OF

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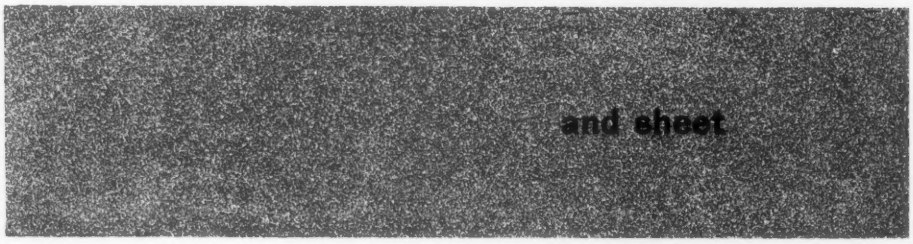

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fabrications

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Thermo Plastics Limited
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Telephone : DUNSTABLE 1444 (8 lines)
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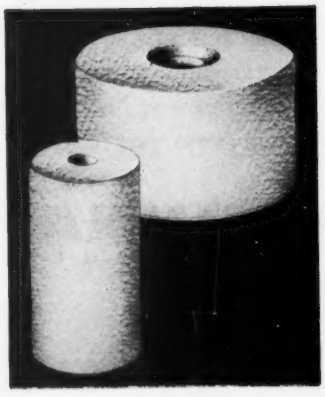
sky high

(Photograph by courtesy of The De Havilland Aircraft Co. Ltd.)

Fi-Vi



Fi-Vi is the material from which the vent valve floats are made for the Comet 4 fuel tanks.

These Fi-Vi floats are continuously immersed in the fuel and yet, completely withstanding all deleterious effects, they perform the vital function of ensuring a smooth flow of fuel to the engines.

Fi-Vi is unplasticised PVC expanded to about 35 times its normal bulk into a non-interconnecting cellular structure having a density of from 1.5 to 6 lb/cu. ft. depending on the grade employed . . . and manufactured only by Whiffens for use in a wide variety of industrial applications. For more detailed information please request Whiffens publication No. Q/FV/2.

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W44

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Aboard the B.O.A.C. Comet IV...

... everything possible is done for the comfort of passengers, and modern materials are used to enhance the interior decor. Among them are WARERITE Plastics, which are used for the individual tables seen in this picture . . . the working surfaces of the pantry and bar . . . the sink deck and dressing-table cupboard facings in the ladies' powder room and surfaces of the meal tray boxes and refrigerator.

Equally important are the unseen applications of other BAKELITE Plastics . . . the Industrial Laminated material used extensively for the electrical equipment, for instance. In the actual production of these aircraft, too, Laminated Densified Wood is used for tooling, so that BAKELITE Plastics play their part both on the ground and in the air.

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Bakelite Limited manufacture an extensive range of plastics materials and maintain a technical service unequalled in the industry. No matter what your plastics problems, this service is at your disposal. SLOane 0898 is the telephone number.

TGA G83P

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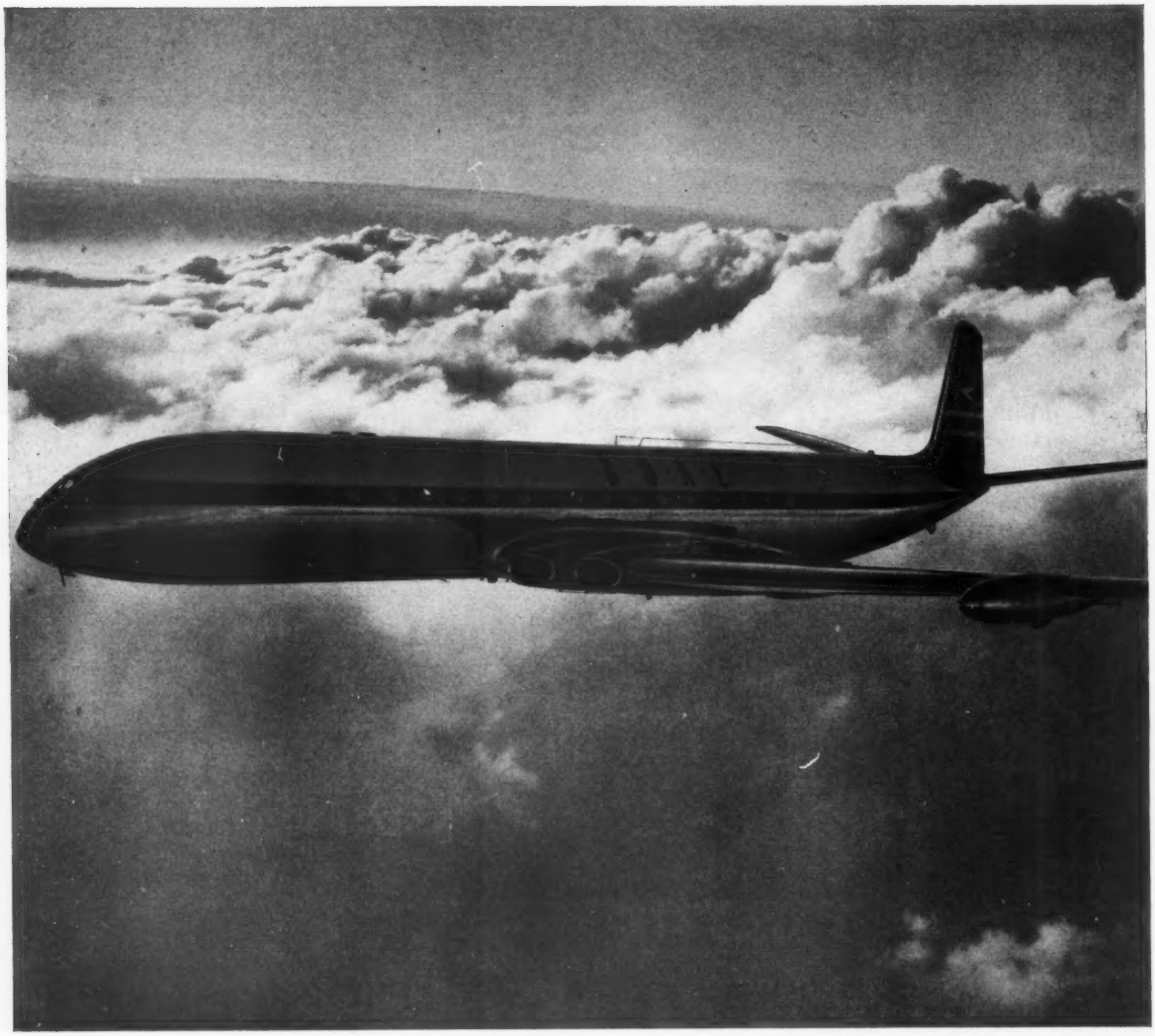

'Perspex', 'Darvic', and 'Fluon' are used in the de Havilland Comet 4, which recently became the first jet airliner to enter transatlantic passenger service.

I.C.I. plastics chosen for Comet 4

Three I.C.I. plastic materials were chosen for the B.O.A.C. Comet 4, the world's first jet airliner to enter transatlantic passenger service. The very successful interior decoration schemes in the Comets which make use of 'Darvic' and 'Perspex' were designed for B.O.A.C. by Gaby Schreiber.

'Perspex' acrylic sheet was used for the lighting fittings, windscreen and windows. This extremely handsome material is tough yet light and is easy to clean and maintain. It will last indefinitely and is affected neither by bad weather nor atmospheric changes. 'Perspex' is easy to heat shape and has an extremely high light transmission.

'Darvic' p.v.c. sheet was chosen for the window surrounds and mirror surrounds in the toilet compartments. 'Darvic' is a tough, light material which is rigid even in thin sheets. It is very easily cleaned and is absolutely hygienic. It resists corrosion and is available in a range of attractive colours.

'Fluon' p.t.f.e. compounds are used in the navigational aid equipment. Among the many properties which commend the use of this unique and extraordinarily inert plastic in aircraft are: exceptional working temperature range (−80°C. to +250°C.); resistance to corrosion and degradation from ageing over an indefinite period; excellent chemical and electrical properties; ability to withstand frettage and vibration even at high temperatures; and toughness combined with flexibility.

'PERSPEX' 'DARVIC' 'FLUON'

'Perspex', 'Darvic' and 'Fluon' are registered trade marks, the property of I.C.I.

IMPERIAL CHEMICAL INDUSTRIES LIMITED · LONDON · S.W.1

P.690

Planning Comet IV meant

THINKING AHEAD

PLAN FOR PROGRESS WITH TENAPLAS PLASTIC PRODUCTS

Extrusions
In an unlimited range, from capillary size up to 18 inches diameter, using acrylics, nylon, polythene, all types of p.v.c., polystyrene and butadiene styrene copolymers. To standard sizes and sections or any special designs for particular applications.

Vacuum Forming
Keeping abreast of rapidly increasing demands, articles already produced by this process range from small lighting fittings to deep drawn trays several square feet in area. Materials used include perspex, polystyrene, polythene and p.v.c.

Fabrications
An unusually wide range of service is offered embracing special items for the Chemical Industry. Extremely complex installations of many kinds have been completed in various materials which include polythene, high and low density; and p.v.c., rigid and high impact.

Epoxy resins
Specially designed tools for press work and vacuum forming. Drilling jigs made from epoxy resin glass-cloth laminates. These have already been perfected by Tenaplas for this relatively new branch of plastics manufacture.

TENAPLAS Contributions to the Comet IV

Float Assemblies for content indicators in the forward water tank. Vent Pipe Assemblies for batteries and accumulators in the electrical equipment bay.

Plastic tubing for rear and forward water systems.

No matter what products are involved, if they can be made in plastic, Tenaplas can make them. The Tenaplas way is to take problems and solve them.

Principals and Design Engineers are invited to discuss their needs with Tenaplas representatives who will gladly advise on all aspects of plastics applications.

TENAPLAS

Upper Basildon, Nr. Pangbourne, Berks.
Tel: Up. Basildon 333.

A Member of the Camp Bird Group of Industries.

In a recent case of Uncivil Law
Mr. Justice Bloop remarked

"Little Horses? Little Horses? WHAT ARE LITTLE HORSES?"

Whereupon the defendant, turning a bright purple and brushing aside a number of gold plated, diamond studded Counsel, whom he had retained and refreshed at fabulous fees, leapt to his feet and cried: "My Little Horses are the driving force of the motors that power the World's Finest Power Tools, Electric and Pneumatic. Some of them ¼ h.p., some ⅛ h.p., and some more or less and notwithstanding. *Big* Motors — *Big* Horsepower; *Little* Motors — *LITTLE* HORSEPOWER — DESOUTTER HORSEPOWER. All the world knows and loves my Little Horses . . ."

At this point loud N-e-i-g-h-i-n-g was heard from the public gallery, and His Lordship ordered the court to be cleared.

FASTEST—Type O3, High Speed Pneumatic Grinder—70,000 rpm.
SLOWEST — Type R39, Rotor Pneumatic Drill of 165 rpm. For drilling Titanium.
BIGGEST — Type H2, Electric Drill, ⅜" chuck.
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RUMMIEST — Type M4, Special Purpose Full Return Head Pneumatic Drill. Drills holes backwards.
MOSTEST—25-motor Multiple Nutrunner for engine head assembly. Tightens 25 nuts at once.
INGENIOUSEST — Electric Oscillating Saw, 18,000 strokes p.m. Cuts surgical plaster but not the skin.

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Little Horse POWER TOOLS

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Save Weight

MAINTAIN STRENGTH

Fan housing photograph by courtesy of "Plastics"

De Havilland chose Durestos for many components on the COMET 4

The fan housing (illustrated right) for the Air Conditioning Unit on the Comet 4 was made from low pressure moulded Durestos felts. It is also used for the coil formers, cable ducting and cleats. Another fine example of the importance of Durestos to the Aircraft Industry.

WITH TURNERS

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Resinated Asbestos Moulding Materials

TURNER BROTHERS ASBESTOS CO. LTD. ROCHDALE ENGLAND

A MEMBER OF THE TURNER & NEWALL ORGANISATION

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Cobex for Aircraft Fittings

Light, tough, easily formed and resistant to fire and corrosion—no wonder so many fittings and accessories today are made from COBEX. Cobex/Velbex Sheet was used in the construction of the side and leg panels of the passenger seating.

Cobex Regd.

RIGID VINYL SHEET *(A.I.D. & A.R.B. approved)*

BX PLASTICS LTD.

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We're skating on thick ice

When we say that we can execute your orders to the highest standards and in the best materials, with uniform quality throughout, and deliver them in bulk on or before time, we are not just making empty claims without the means or intention of carrying them out.
Behind these words we have an organisation designed specifically to do just this and it's doing *just this* at the moment for the many well known concerns that we have on our books. It can do it for you too.

As supplied, in a special heat resisting phenolic material, to The Zenith Carburetter Company Limited.

Metropolitan Plastics Limited

Specialists in thermo-setting plastics for the Aircraft and Automobile industries

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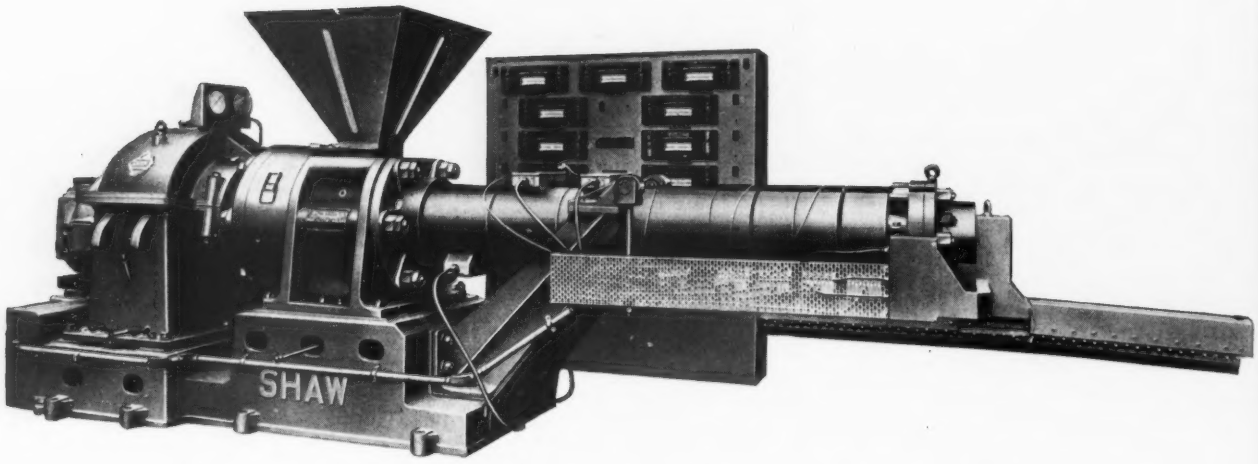
PLASTIC EXTRUDER. Fine temperature control is a vital feature of Francis Shaw extruders. All-electric heating in separate zones is provided, each zone being separately controlled by proportioning instruments. A wide range of screw and die designs is available for the production of piping, sheeting, sections and the sheathing and insulation of cables. Extruder sizes from 1″ to 12″.



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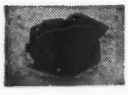
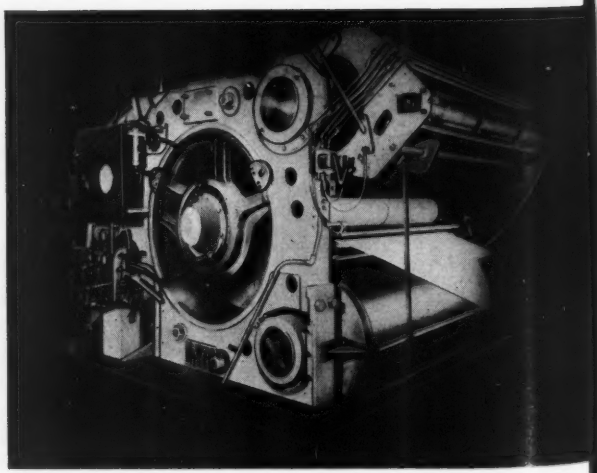
quality engineering puts efficiency into Shaw machines

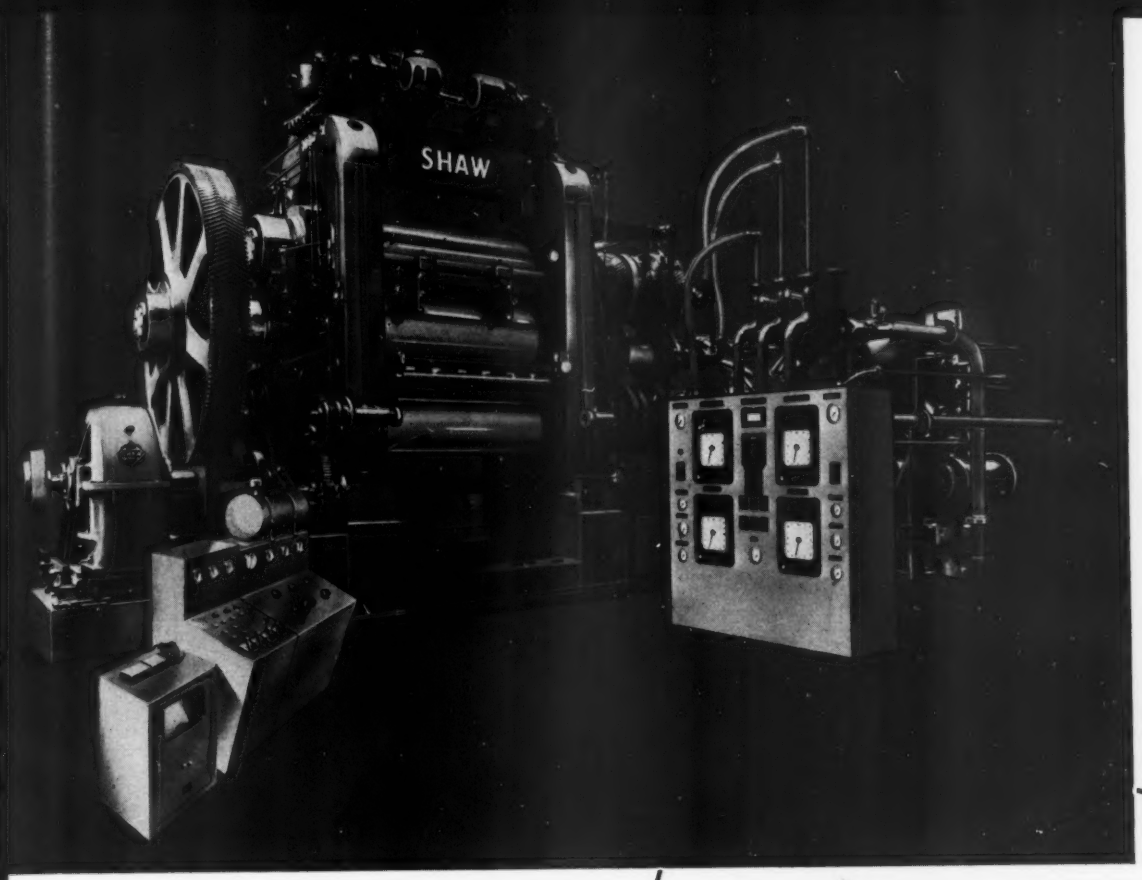
The cost-cutting performance of every Francis Shaw machine and its thorough dependability are the result of long experience and unvaryingly high standards of engineering in every detail of manufacture.
Close-limit accuracy and rigorous inspection during manufacture guarantee to the user a consistently high quality output from Francis Shaw equipment.



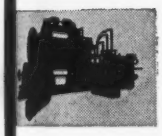
SHAW ROTOCURE. For perfect quality continuous curing of belting, matting, flooring and other flat products, eliminating the time-wasting operations of opening, cooling, re-heating and closing of hydraulic presses.



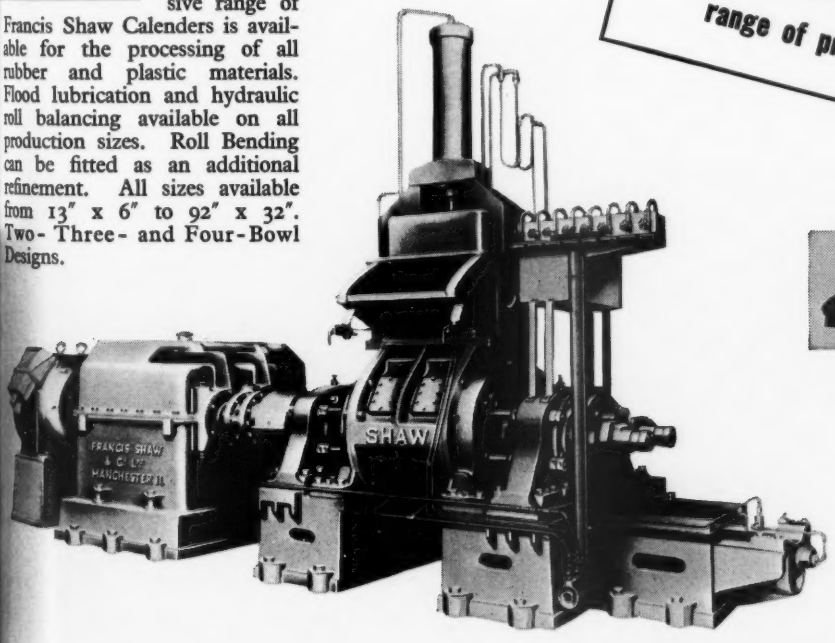
QUALITY ENGINEERING FOR QUANTITY PRODUCTION

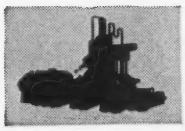


Francis Shaw are available for the design, manufacture and installation of a wide range of processing equipment



CALENDER A comprehensive range of Francis Shaw Calenders is available for the processing of all rubber and plastic materials. Flood lubrication and hydraulic roll balancing available on all production sizes. Roll Bending can be fitted as an additional refinement. All sizes available from 13″ x 6″ to 92″ x 32″. Two- Three- and Four-Bowl Designs.





INTERMIX. A robust high efficiency heavy duty internal mixer for mixing plastic compounds at lower-than-normal temperatures. It is supplied with steam heating for plastics and other materials, and the exclusive rotor design ensures consistent high quality mixing.

FRANCIS SHAW & COMPANY LIMITED MANCHESTER II ENGLAND

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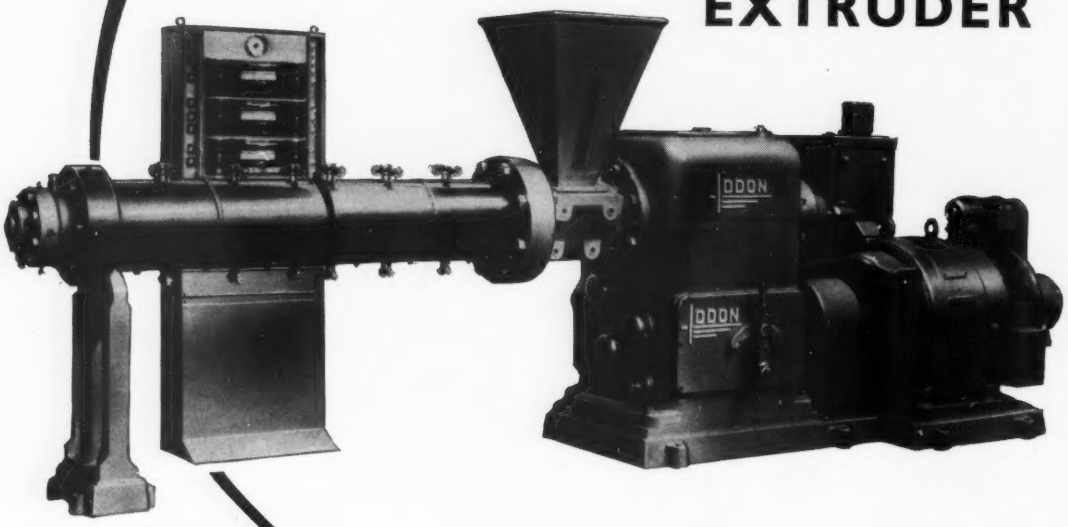
LONDON OFFICE 22 GREAT SMITH ST SWI TEL ABBEY 3245 (3 LINES) GRAMS VIBRATE LONDON TELEX 2-2250

NON-STOP PRODUCTION

TYPE XL EXTRUDER



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Type "XL" Extruder with barrel zoned for heating and cooling to ensure accurate temperature control. Variable speed motor drive through three-speed gear box.

Since we first advertised this machine in 1955, it has worked continually night and day producing precision quality extrusions; once more illustrating the reliability of IDDON-built machines.
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London Office :- 79 Baker Street W.1.

Photo by courtesy of the Projectile & Engineering Co. Ltd. *PECO install West temperature controllers on injection moulding, extrusion and die-casting machines.*

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Please ask your area representative to let me have full details of the West Temperature Controllers.

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" Aquamatic " water pistol by H. Reynolds, moulded in a Lustrac High Acetyl C.A. to withstand continuous contact with water

Even a youngster's armament has to stand up to a lot of fun. Constant contact with water can quickly cause trouble. To maintain dimensional stability in the working parts of the water pistol Lustrac recommended a special High Acetyl grade material—tests showed stability even after months of continuous water contact.

This is just one example of how Lustrac research tailor-makes the Cellulose Acetate compounds to suit individual products . . . both injection moulded and extruded . . . from toys to shoe heels . . . from lampshades to lipstick cases. As regards colour matching and prices Lustrac pride themselves on a fast and realistic service.

ASK Lustrac PLASTICS

ABOUT CELLULOSE ACETATE COMPOUNDS

Manufacturers and Technical Advisers:
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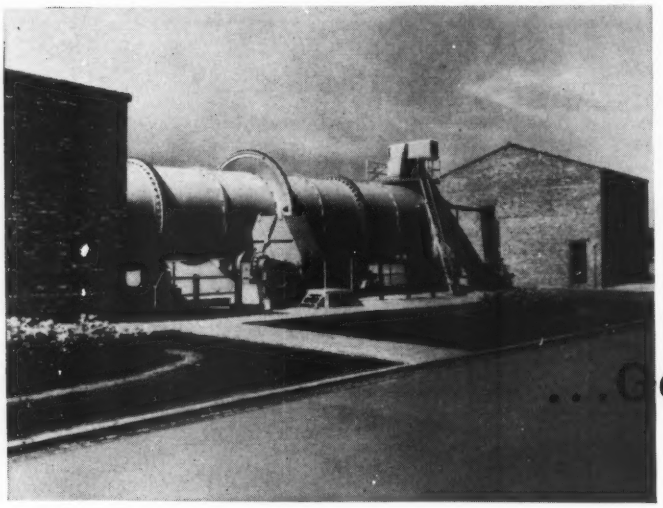

The above illustration shows the huge "Dano" refuse and composting plant at Edinburgh, manufactured at our works and erected by our own personnel.

...Generally speaking

our first products were not of a general nature but were speciality equipment for the neighbouring paper-making industry. Being general engineers, however, in so far as we were always alive to any opportunities for developing new types of product we steadily expanded and consolidated until we had customers and plant in almost all parts of the world. And this process is continuing today.

It is rather strange how varied our products and services have become yet all are interconnected with each other in some way or another. For instance allied to our first products we manufacture stretching, conditioning and varnishing machines for paper for the insulation of electric transformers and cables. Closely involved in the impregnation of the paper insulated cables, etc., is high vacuum equipment, a branch that has unlimited applications in industry, and medical and scientific laboratories. Then again, machinery for the rubber and plastic insulation of electric cable, from fine distribution cable up to large power cable, is yet another of our specialities.

Handling infinitely sensitive and highly accurate equipment on the one hand and enormously large structures weighing scores of tons on the other is all part of our work. If you are only merely interested send for a copy of our " Summary of Products " leaflet. You might find that we may be able to help you sometime.

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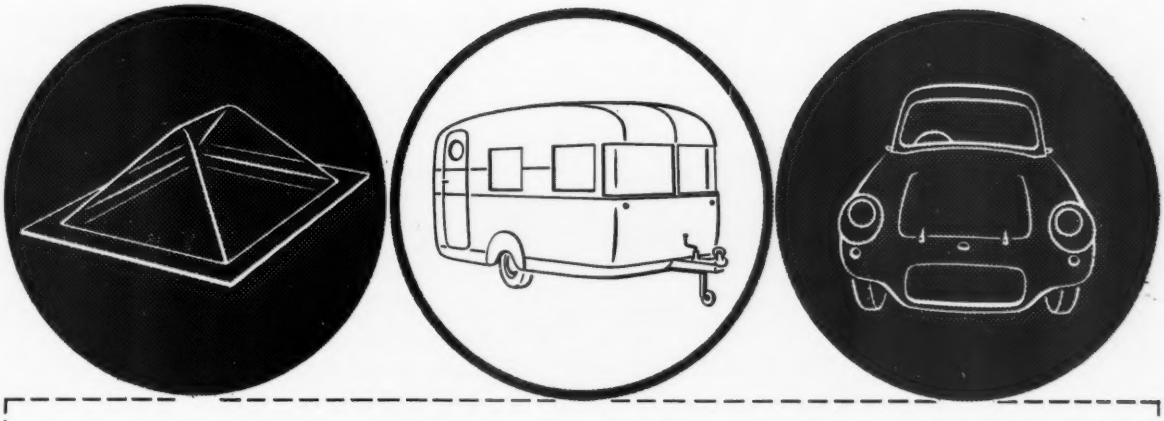
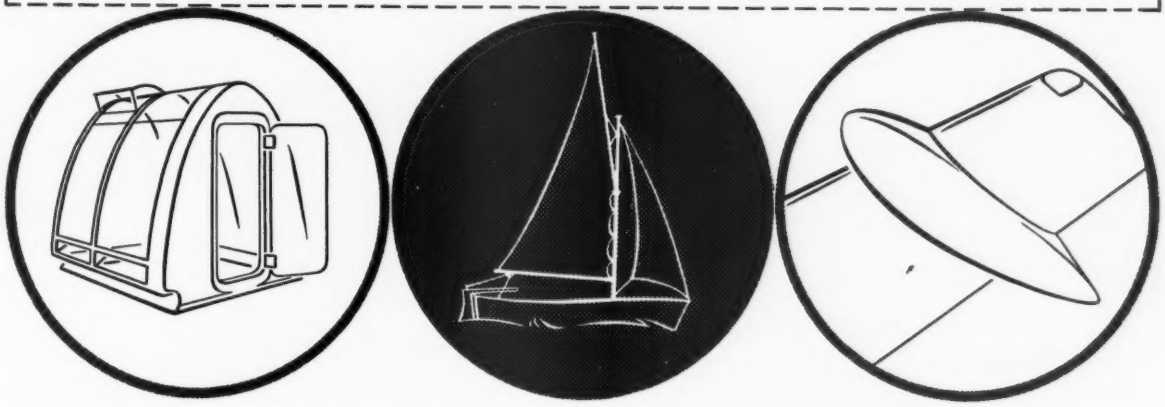


For the manufacture of

POLYESTER RESINS



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GENERAL PURPOSE PLASTIC SHEET WELDER

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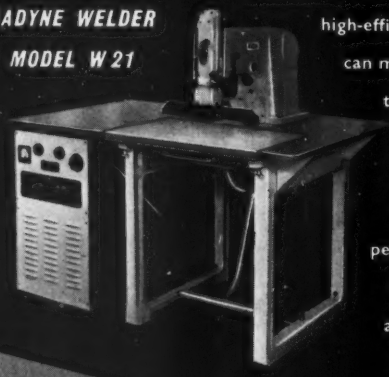

RADYNE WELDER MODEL W 21

SPEEDIER PRODUCTION OF FANCY GOODS

RADYNE PRESS WELDER MODEL PW 50/S

The sliding loading frame of this 6 kW Radyne welder enables fast and continuous production to be maintained. One tray is loaded whilst the patterns on the other are welded. Single or dual control. It can also be used for profile welds up to 240".

RADYNE

The finest range of plastic sheet welders

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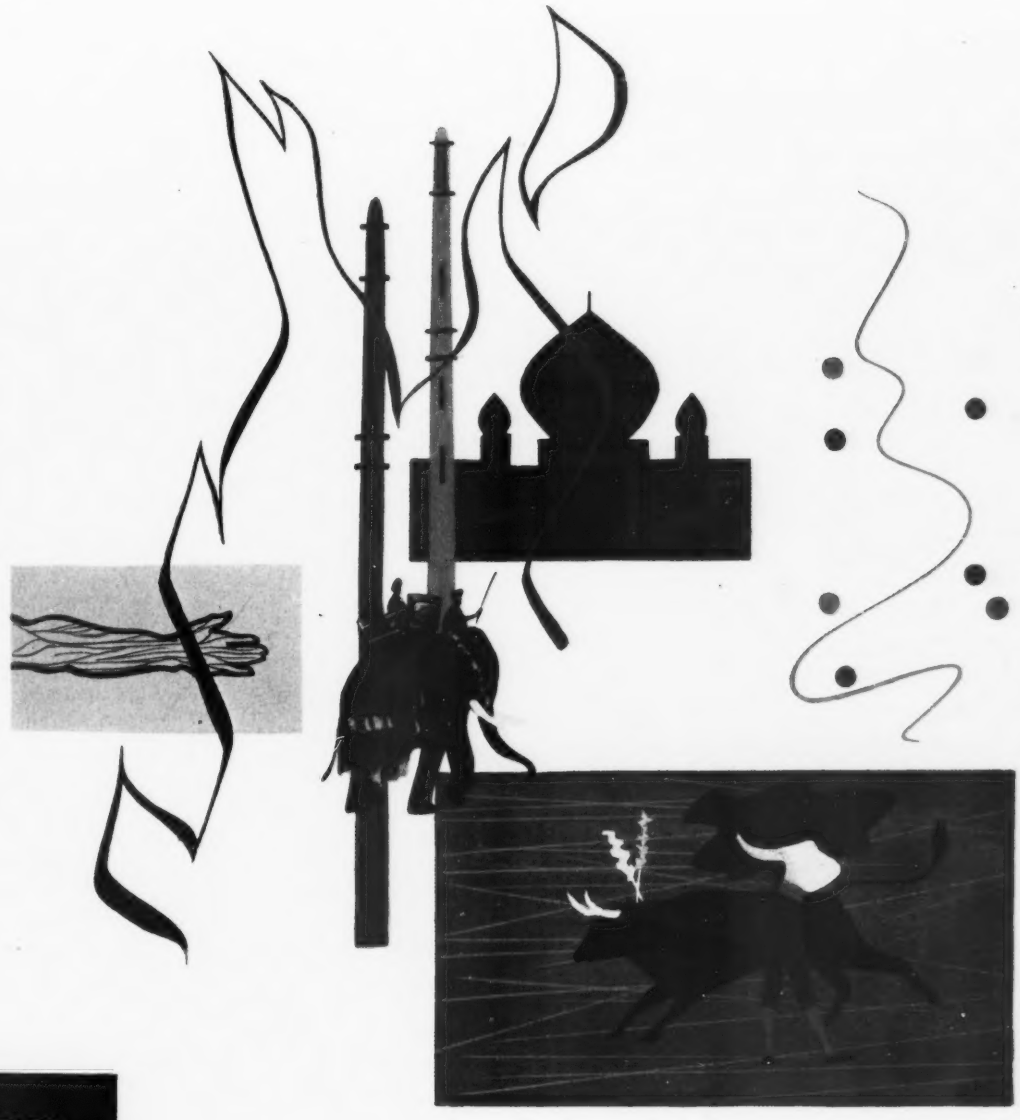

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For countless generations, the colour RED has held almost a sacred precedence in the courts of India where it is a 'must' in every ceremony and pageant. In the golden land of Spain too, this glowing, torrid colour plays an ever-present part in the national kaleidoscope of sunlit brilliance.

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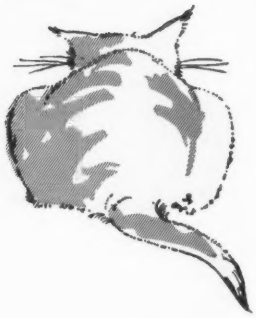

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we're always interested in your problems

Thirty years of "know-how" and a team of enthusiastic back-room boys are ready to help you solve any plastics problem. Our three specialist factories produce a full range of compression, injection or fibreglass mouldings. Good design, precision and efficient mass production at competitive prices are the Insulators' trade marks.

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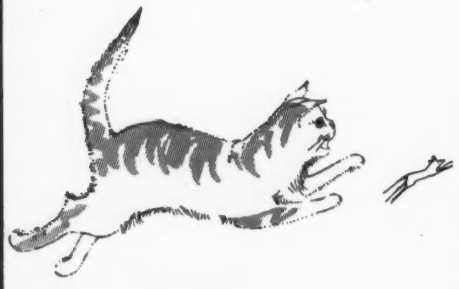
and no job's too small!



We're just as good at small intricate parts produced to close tolerances as the big jobs for our 1,000 ton compression presses or 32 ounce injection machines. You'll find you get the same high standards of quality and service whatever the size of your job. If you'd like to know more about us, just write your name and address in the margin of this advertisement and post it today.

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These Shell and BP signs are made from 'Perspex' by Thermo Plastics Limited and the service station sign is made from 'Darvic' by Gowshall Limited.

'Perspex' is the registered trade mark for the acrylic sheet made by I.C.I.

'Darvic' is the registered trade mark for the rigid p.v.c. sheet made by I.C.I.

'PERSPEX' 'DARVIC'

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P.673

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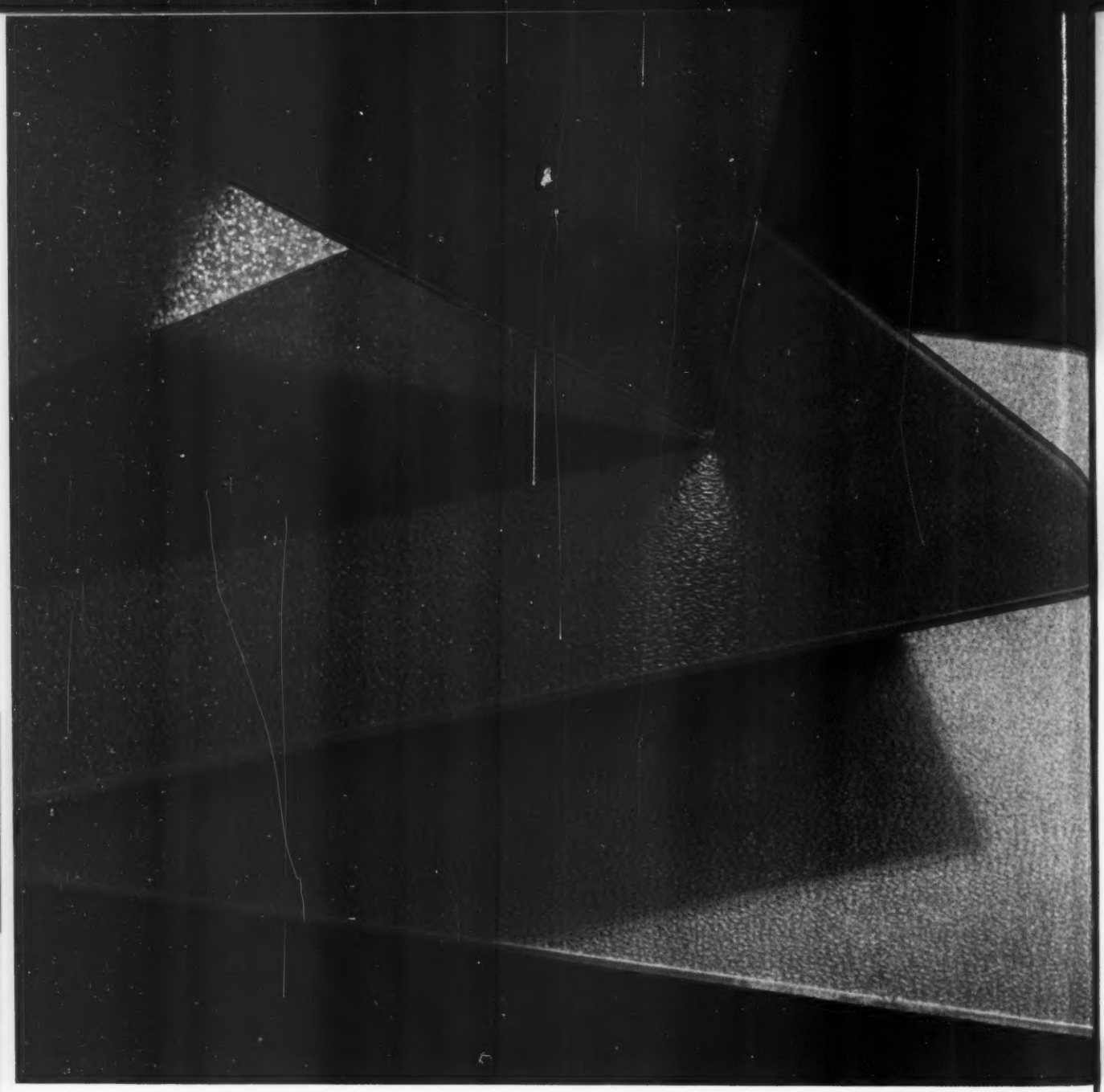

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BUSS Ko-Kneaders (List System) have proved themselves in many years' service for the continuous processing of plastics. Direct feeding of calender plant. Direct production of regular granulate free of bubbles

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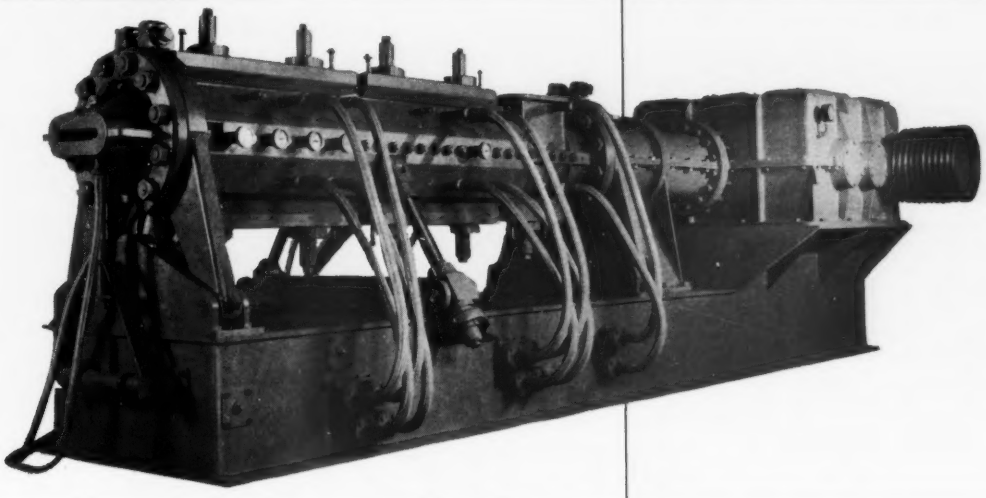

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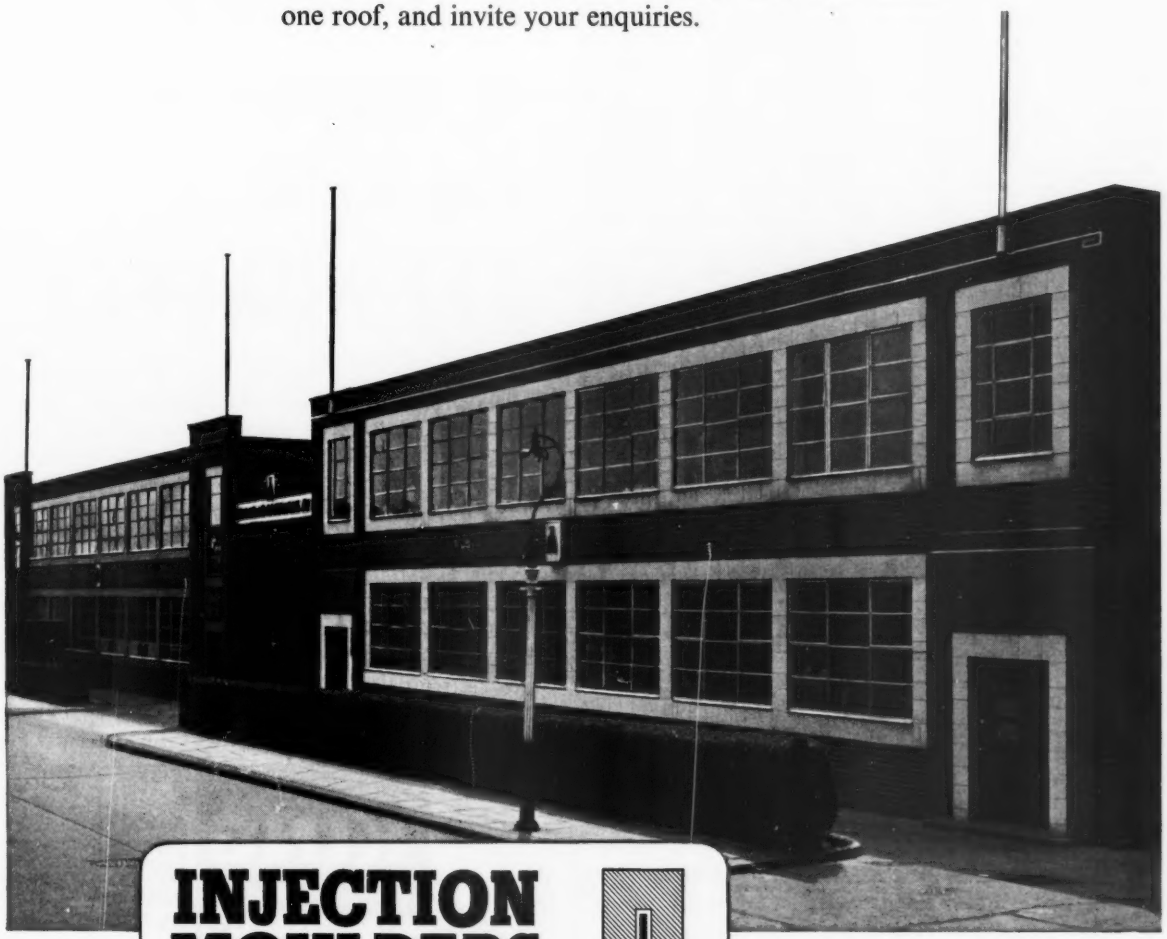

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IM 65

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Polyester Division

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THE BRITISH PLASTICS FEDERATION
P & B
INJECTION MOULDING Specialists
. . . you may think there are snags but our wide experience of injection moulding can help you overcome your difficulties. Why not consult us right away?
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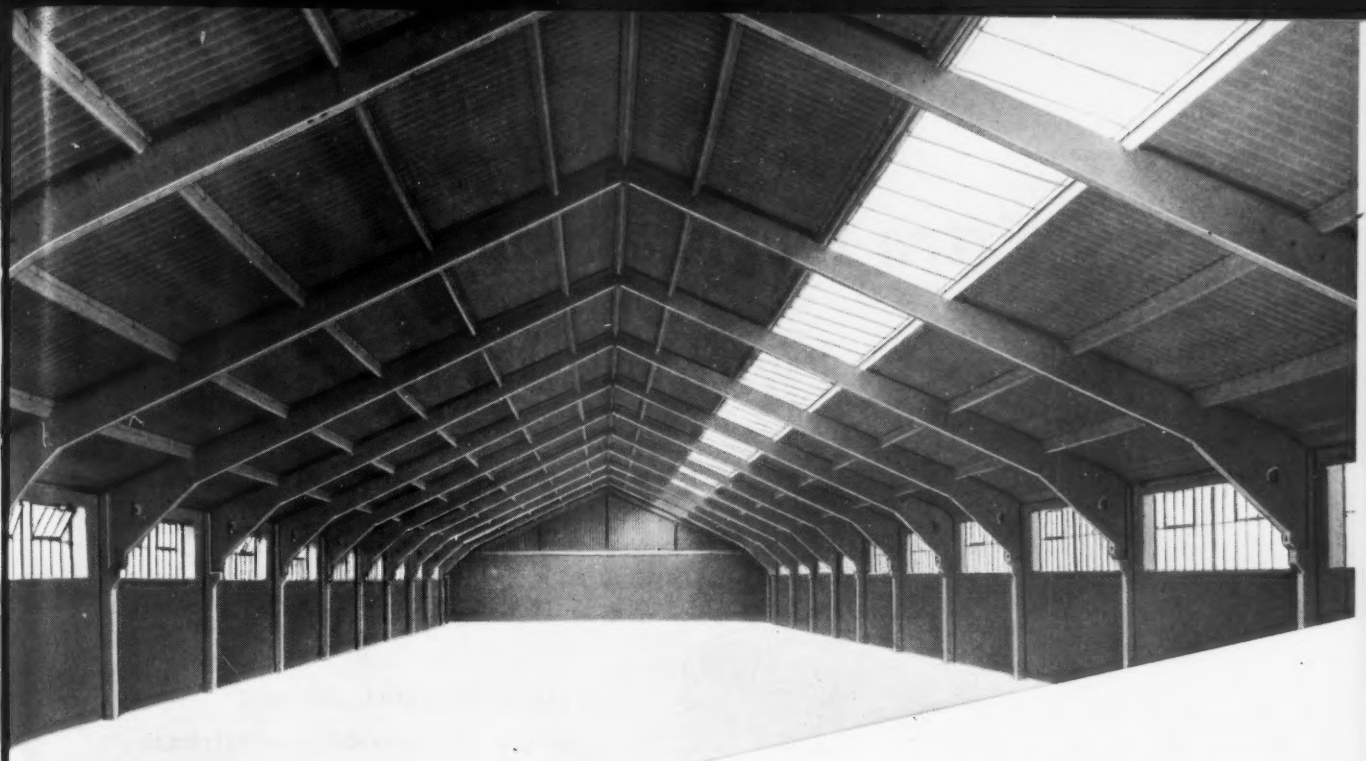
Telephone: **COLINDALE 2266/7/8** *Telegrams:* **PUNFIBARS, HYDE, LONDON**



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ATCOST-BUILT *factories, warehouses, transport-sheds, workshops, canteens, etc. are of the highest quality, yet competitively priced. They are fire-resistant, easily-extendible and require no painting or maintenance. For free, 24-page illustrated brochure, and details of our comprehensive service, complete and post this coupon now!*

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P

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THE PANTILES, TUNBRIDGE WELLS, KENT
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Extra toughness all round

with GEON RA-170

HIGH IMPACT PVC

Fifteen-times the toughness of
ordinary PVC *plus* high tensile strength
and lightness *plus* resistance
to chemicals and solvents.
This combination of properties is
available only with
Geon RA-170 High Impact PVC.
No other PVC compound satisfies so
completely the requirements of
manufacturers of piping for the
chemical industry, the petroleum
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of civil engineering.
Write for Information Sheet G105/51.

Photograph shows
High Impact PVC piping made
by Chemidus Plastics Ltd
using Geon RA-170.

Geon is a reg'd trade mark

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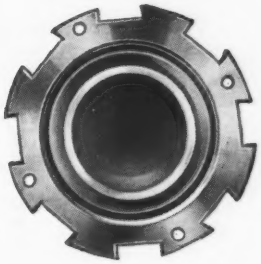
If you have a pipe problem

DUNLOP CAN HELP!

Fleximet for instance—the all-stainless steel flexible pipe that carries a very wide range of fluids or gases equally well at the extremes of high and low temperature. DUNLOP are specialists also in reinforced high and low pressure flexible pipes embodying P.T.F.E.* and rubber-like materials. *Dunlop technicians are available to advise on all problems concerning the installation and use of flexible pipes. Details from Dunlop Rubber Co. Ltd., St. Georges Road, Coventry, Telephone 64171.*



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MAKE PIPES BETTER

TO LAST LONGER

* *Polytetrafluoroethylene*

EH/904

The 'M' plan...

Before we start making moulds we make plans . . . obviously. But not only on paper—first we plan in our minds. We pool the expert knowledge of our key men, and settle the mould plan—how to mould, where to split and what material to specify.

For such right, hard thinking pays dividends in the long run . . . dividends on your capital . . . long runs on your machines.

Centre, above, is B. Slater, our Planning Engineer, a man whose specialised study of plastics technology is backed by practical experience in the shops and on the drawing board. With him on the job are H. Whitton, Chief Designer and C. East, Works Superintendent—who, incidentally, won the Model Engineer Exhibition Championship Cup in 1956.

Their plan is a master plan

UNIVERSAL TOOLS LTD.

MOULDMAKERS TO THE PLASTICS INDUSTRY

TOOL MAKERS ASSOCIATION CAUSE MEMBER

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Ask Berk for P.V.C. Stabilisers

FLOMAX 25 for clearer clears and brighter colours. FLOMAX 25 is a new liquid barium/cadmium organic outstanding for clarity, economy, easy use.

It gives extraordinary heat and light stability and contributes to high resistance to yellowing and plate-out. With plastisols it gives low initial paste viscosity and as it is free from soaps there is little viscosity build-up.

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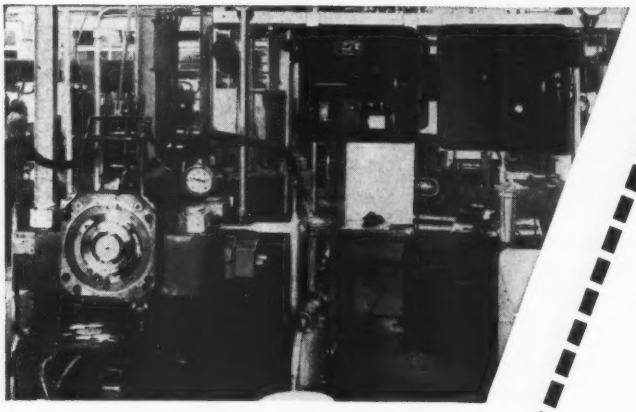
Taylor Controls

for PHILIPS RECORDS



HELP THE MUSIC GO

ROUND & ROUND

AT RECORD PRESSERS LTD.

the well-known **Taylor FLEX-O-TIMER**

TIMED PROGRAMME CONTROLLER has been

fitted recently to a bank of 30 presses at

the modern factory of Record Pressers Ltd.

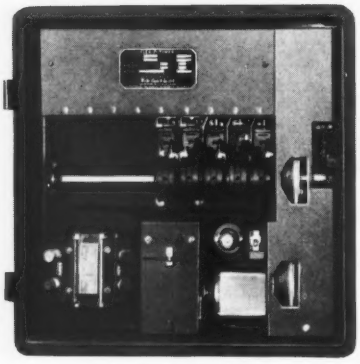
24 hours a day, these instruments are continuously

controlling the complete sequence of operations of

the record moulding presses.

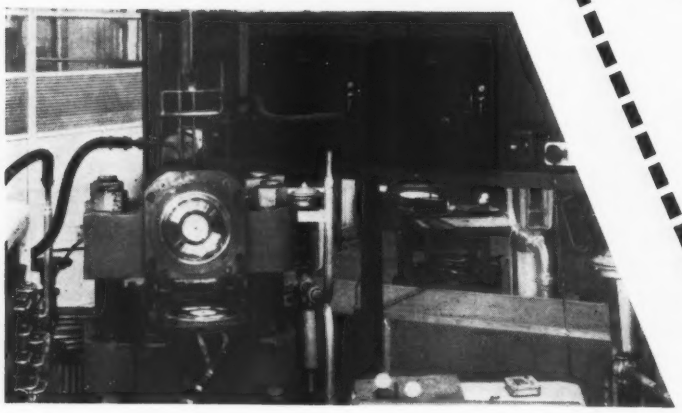
Write for Bulletin 98350/154 G.B. for performance details

of Taylor FLEX-O-TIMER instrumentation.



FLEX-O-TIMER

CONTACT TAYLOR NOW



ANOTHER RECORD OF ROBUST RELIABILITY ACCURACY AND SATISFACTION

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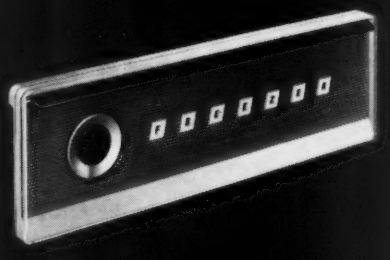
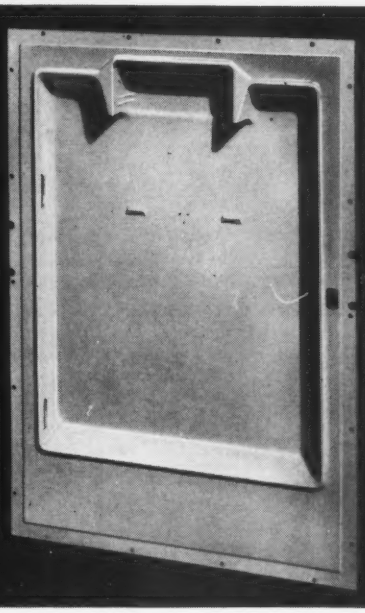
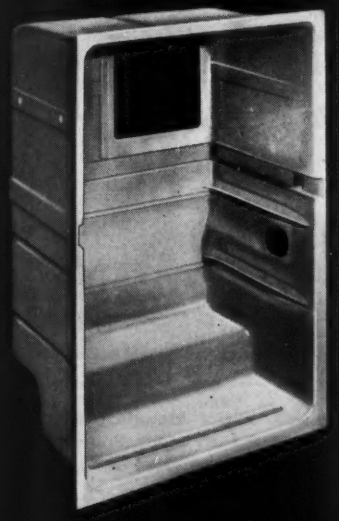
Telephone: Larkswood 3371/6

A subsidiary of the Taylor Instrument Companies, Rochester, N.Y. U.S.A.







HALEX

produce a full range of industrial mouldings and plastic fabrications to the high standards demanded by every kind of industry.

HALEX
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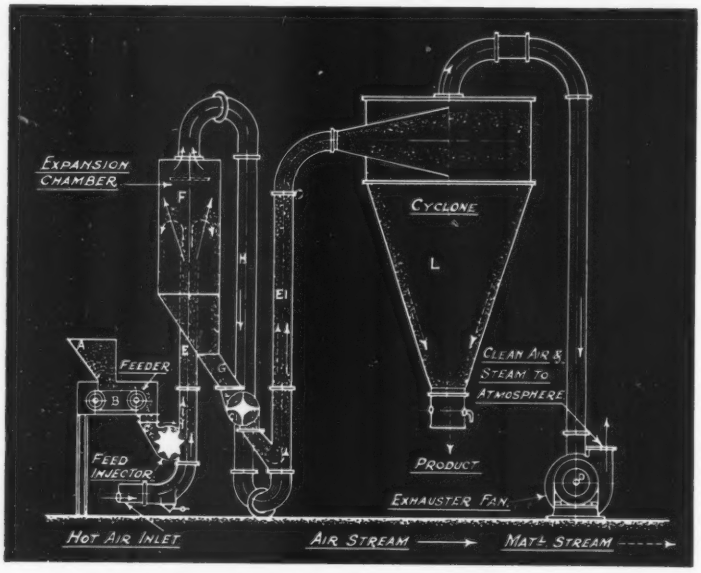
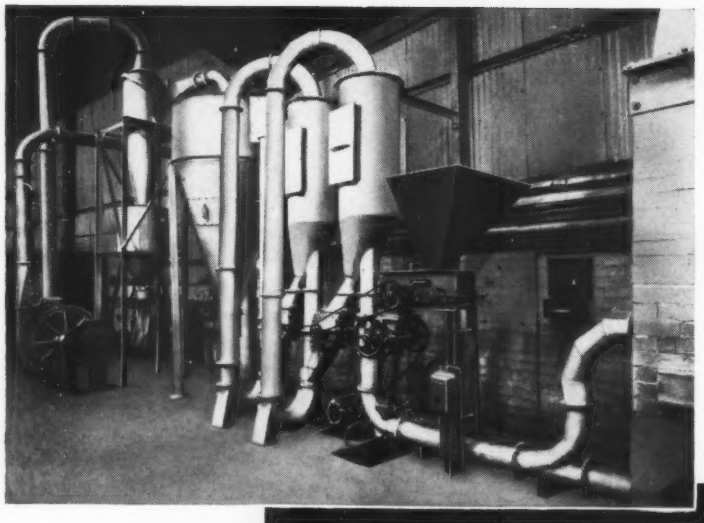
HIGHAMS PARK, LONDON, E.4.

Telephone: Larkswood 2345

sawdust dances in *HOT AIR STREAM*





For drying sawdust and other filler ingredients for plastics, the British 'Rema' Pneumatic Dryer is quick and effective and takes up relatively little space.

At all times during the drying the particles are separated and swept by high-velocity hot gases; this gives an extremely rapid transfer of moisture from the material to the air stream—drying takes place in less than one minute and the material never has time to get too hot.

This system of pneumatic drying is also very suitable for any materials which are easily damaged by breakage or overheating—flaked materials, crystalline products, etc.

Sizes: from ½ ton to 20 tons per hour.

BRITISH 'REMA' PNEUMATIC DRYER

BRITISH 'REMA' MANUFACTURING CO. LTD.
PROPRIETORS: EDGAR ALLEN & CO LTD.
ONE INDUSTRY ROAD · SHEFFIELD 9

PI/BR25
To British 'Rema' Manufacturing Co. Ltd
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Please post "Drying Equipment" to:
Name.....
Position.....
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Address.....

THIS IS **the TOTE BIN**

DISCHARGING
INTO THE PROCESS
without product loss or contamination

TOTE
BULK MATERIALS HANDLING
SYSTEM

May we send you an Illustrated Description of the Complete System
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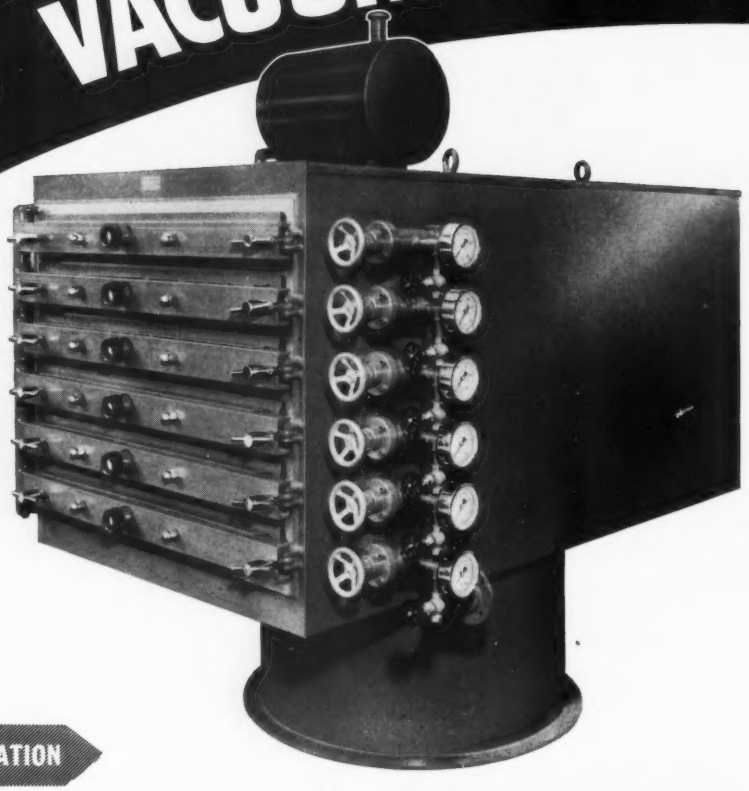
THE VACUUM DRYER WITH INDEPENDENT COMPARTMENTS

For Granules, powders and all low moisture content materials particularly in the Plastics Industry.
Nylon · High Density Polythene · PTFE · etc.

THE C-3 VACUUM DRYER



A special feature of the C-3 Vacuum Dryer is the arrangement of the drying space which is divided into small independent compartments. This means that drying can commence immediately a compartment has been filled and can continue uninterrupted while other compartments are being filled. Once the door of a compartment is closed that compartment is under vacuum (30mm Hg absolute) within ONE MINUTE.

SEMI-CONTINUOUS OPERATION

RAPID, EVEN DRYING

HIGH OUTPUT

WIDE TEMPERATURE RANGE (ambient to 150°C)

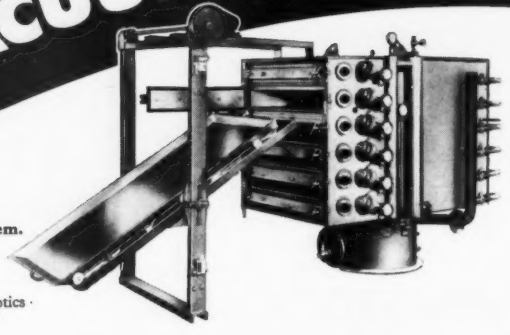
INEXPENSIVE OPERATION

Dried materials need not be stored in large quantities with danger of absorption of moisture from the air. The C-3 Vacuum Dryer can safely be used for drying materials giving off toxic or explosive vapours.

We are always very pleased to advise on individual drying problems. When writing it will save time if you will let us have the following information:—

1. *Highest permissible drying temperature.*
2. *Initial moisture content.*
3. *Final moisture content required.*
4. *Required output of dried material (e.g. per 24 hour day, or per 8 hour day).*

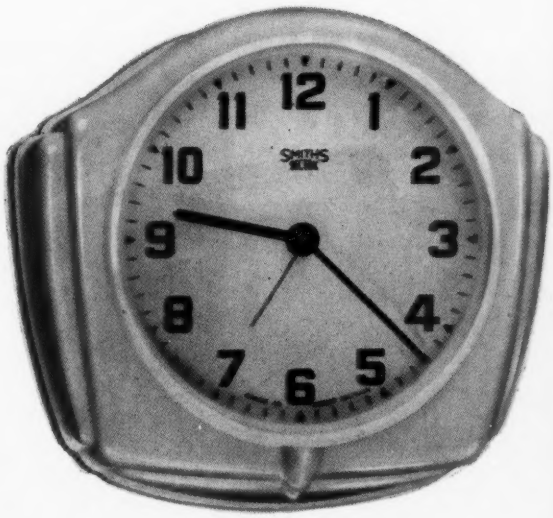
C-5I VACUUM DRYER

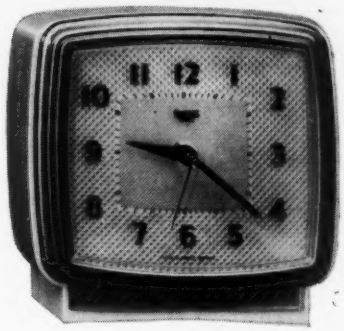


New CALMIC Vacuum Drying System.
For the rapid, even and safe drying of high moisture content materials, Pharmaceuticals · Antibiotics · Veterinary preparations · Dyes and pigments · Precious metals.

CALMIC ENGINEERING

CALMIC ENGINEERING CO. LTD., CREWE, CHESHIRE. *Tel: CREWE 3251/7*





In a matter of seconds...

SMITHS CHOSE LUSTREX

Smiths Clocks are renowned throughout the world for their good looks and reliability. And no wonder — for Smiths attach great importance to selecting the finest materials for use in their manufacture. That's why they chose Lustrex. This high-quality polystyrene could be relied upon to uphold a fine and well-established reputation.

Lustrex can help you just as it is helping Smiths. No matter what job you may have in polystyrene, there is a grade of Lustrex available to give you the best possible mouldings. Write now for more information.

Lustrex is a Registered Trade Mark.

Monsanto

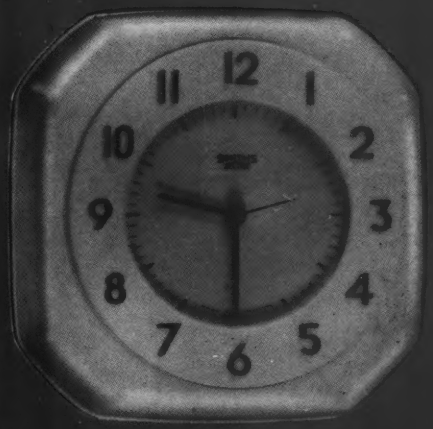
Reg.

MONSANTO CHEMICALS LIMITED, Plastics Division

544 Monsanto House, Victoria Street, London, S.W.1, and at Royal Exchange, Manchester 2

In association with: Monsanto Chemical Company, St. Louis, U.S.A., Monsanto Chemicals (Australia) Ltd., Melbourne. Monsanto Chemicals of India Ltd.

Monsanto



Monsanto chemicals and plastics help industry — to bring a better future closer

We supply:

Extruders with screw diameter of 30, 45, 60, 90 and 150 mm

Complete plants for processing thermo-plastic materials into:

Sheets,
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Profile sections,
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Blown-foil plant for lay-flat folie up to 1400 mm width - S 90 RGV with FAV 1500 -

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Plant for the production of plastic sheet by extrusion, sheet width 1000 mm

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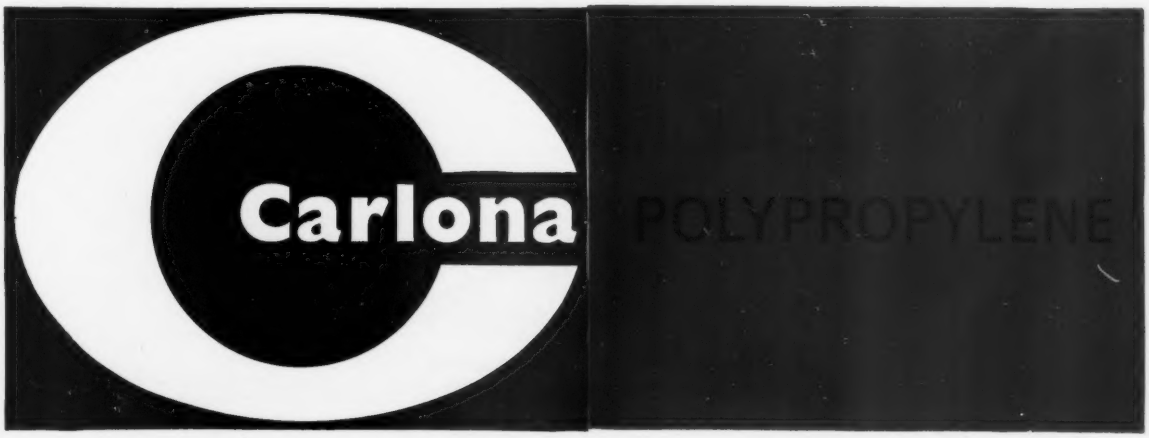
POLYPROPYLENE *for evaluation*

now available from Shell

As a result of continued development in the polyolefin field Shell have pleasure in announcing that they will be adding polypropylene to their CARLONA range. A limited quantity can now be made available for evaluation by the UK plastics industry.



Further information can be obtained from:

SHELL CHEMICAL COMPANY LIMITED

In association with Petrochemicals Limited and Styrene Products Limited

Divisional Offices:	LONDON	Norman House, 105-9, Strand, W.C.2. Tel: TEMple Bar 4455.
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"CARLONA" is a Registered Trade Mark	DUBLIN	53, Middle Abbey Street. Tel: Dublin 45775.

TH/3

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TRADE MARK

CELLULOSE PROPIONATE MOULDING POWDERS

a NEW standard of excellence in plastics

+ dimensional stability
+ superior toughness
+ freedom from odour
+ brilliant moulded finish
+ weather resistance
+ durable surface lustre
+ good flow around metal cores and inserts
+ non-critical flow temperatures
+ superb mouldability for long or short cycles
+ almost invisible weld lines
+ wide colour range

These advantages give Forticel a wide range of applications in a wealth of industries.

Forticel moulding powders are imported from America and are marketed in the United Kingdom by British Celanese Limited, Coventry and London, plastics manufacturers and sales agents in the United Kingdom for Amcel Co. Inc., New York.

Write today to Plastics Division, Little Heath, Coventry or Hanover Square, London, W.1, for fuller details of how Forticel can help *your* sales. Dept P.L.3.

PLASTICS DIVISION · BRITISH CELANESE LIMITED

Celanese House · Hanover Square · London, W.1. Telephone MAYfair 8000
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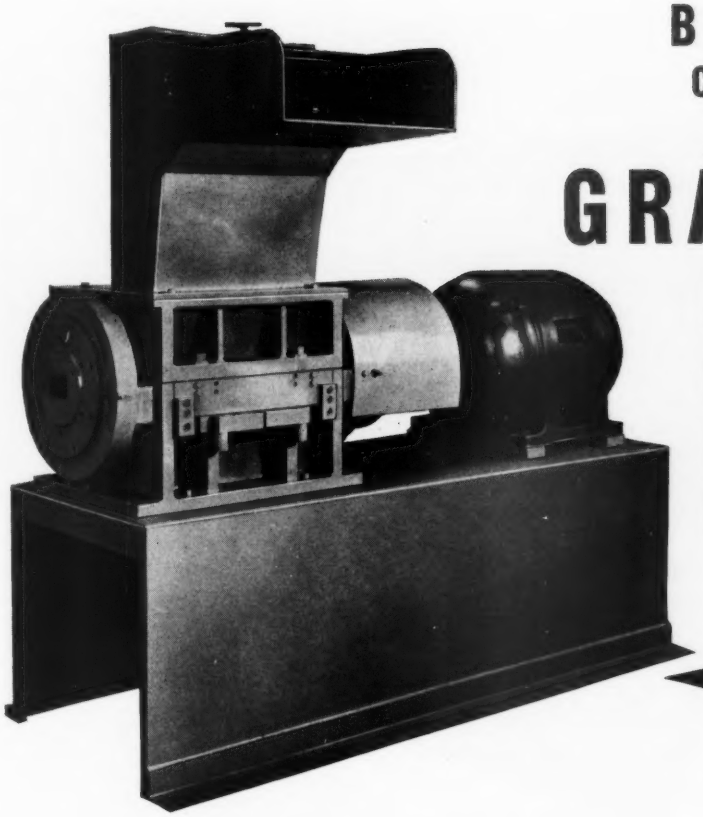
PA4

BURTONWOOD
CUMBERLAND
MODEL 20
GRANULATOR

PELLETIZERS
DICERS
CHOPPERS AND
PRE-BREAKERS



LARGE THROAT OPENINGS— 9″ × 20″
12¾″ × 20″

SUPERB CONSTRUCTION—heavy steel fabrication with deep welds. Rotor and seal rings are heat treated to provide tough undamageable parts, and ground all over to achieve extreme dimensional accuracy and balance.

VERSATILITY—handles "chunky" pieces of toughest plastic materials such as extruder spewing, cylinder purgings and heavy slabs of thermoplastic materials. Special adaptors for handling long lengths of pipe such as kralastic, high impact vinyl and polyethylene.

Model O for use in conjunction with injection moulding and extrusion machines. Mobile, bench, or floor mounting types available.

BESIDE THE PRESS GRANULATOR

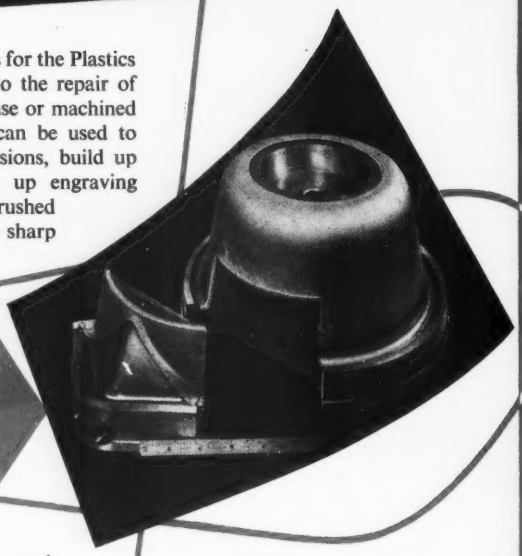
Beside the Press Granulator. Entirely new model, throat size 12″ × 16″.

BURTONWOOD ENGINEERING COMPANY LIMITED

Burtonwood, Warrington, Lancashire. Telephone: Newton-le-Willows 3311 (10 lines)

LOSCA REPAIR SERVICE

The process of electroforming dies for the Plastics Industry has now been applied to the repair of steel dies and cores damaged in use or machined incorrectly or inaccurately. It can be used to increase outside or inside dimensions, build up damaged blades or inserts, fill up engraving ready for re-engraving, rebuild crushed or sunken surfaces, and restore sharp corners.



This is the type of repair of a steel die made possible by the use of the LOSCA process.

The LOSCA Repair Process is not merely the adaptation of an ordinary plating bath, but a development of a specialised process used for the making of dies for the Plastics Industry.
The LOSCA Repair Process has the following advantages:

1. No heat involved, therefore no danger of warping or cracking.
2. No craters around the repaired area.
3. No damage to sharp edges adjacent to repair areas.
4. No pits, if the base is itself sound.
5. No ragged feather edge join lines.
6. Deposits on large or small areas.
7. Internal and external surfaces inaccessible by other means can be repaired.

By the LOSCA method there are none of the hazards associated with welding (frequently used for building up hardened parts), no stresses are built up, there is no danger of distortion; there are no pits or join lines in the finished product. The time factor, too, is extremely important, as most jobs within the size limit can be completed in a few days. As a " get you out of trouble " service the LOSCA repair process is of paramount value.

The following leaflets may also be of interest to you.
LOSCA Hard Nickel Electroformed Dies.
Electroformed Dies for 3-Dimensional Mouldings.
Electroformed Dies for Nylon Gears.
Prototype Die Service.
Electroformed Moulds for Acrylic Teeth.
Electroformed Shells for Slush Moulding P.V.C. Dolls and Toys.

LOSCA is the registered trade mark for all electroformed dies, slush shells and equipment made by

LONDON & SCANDINAVIAN METALLURGICAL CO LIMITED

(TOOL DIVISION)

Wellington Works, Wellington Road, Wimbledon, London, S.W.19. Telephone : WIMbledon 6301-2-3-4

SARO

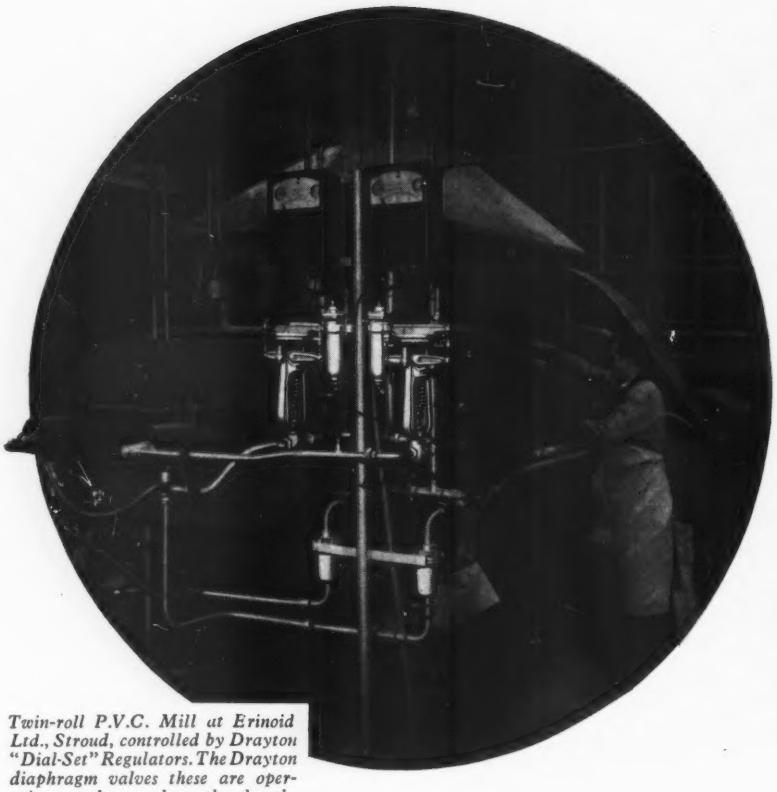
• THE HIGH IMPACT POLYSTYRENE SHEET

No. 6 in a series of advertisements to keep you informed of SARO achievements

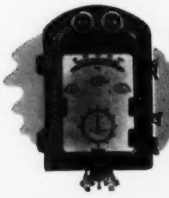
Turn-over in a wide variety of merchandise can be increased rapidly with eye-catching, yet tasteful 'point of sale' displays. This photograph shows a fruit and chocolate display thermo-formed by Bofors A/B, Tidaholm, Sweden.

For full details write to:
SARO LAMINATED WOOD PRODUCTS LTD.
PLASTICS DIVISION, ISLE OF WIGHT
TELEPHONE: COWES 704/708

CALL IN DRAYTON*



Twin-roll P.V.C. Mill at Erinoid Ltd., Stroud, controlled by Drayton "Dial-Set" Regulators. The Drayton diaphragm valves these are operating can be seen beneath, also the Drayton-Armstrong traps on the steam heated rolls.



Air operated controllers with or without recording feature.

Air or water operated controllers; expansion stem type.

On-off electric control. Available with a wide range of thermostatic switches.

Self-operated controllers, for calorifiers, tanks, etc.

Proportioning electric control with electrical or capillary tube transmission.

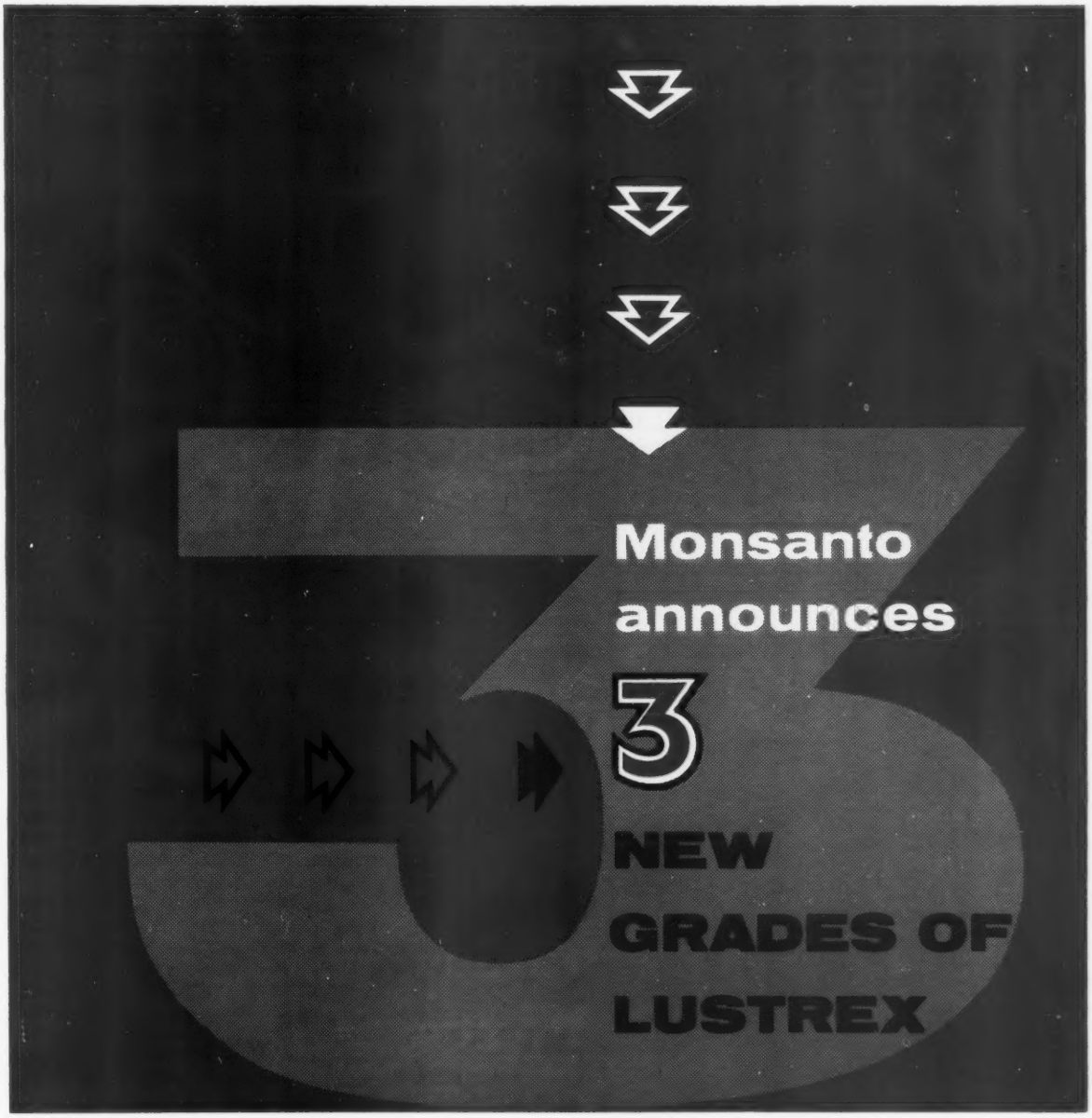
Drayton make an entire range of regulators and automatic control equipment applicable to virtually every kind of industrial processing and of the highest reliability. These include self-operated types, air and water-operated regulators and electrical systems with the complementary control apparatus for each particular application. More than that, we can advise from the widest possible experience on what type of control system will prove most suitable for the requirements. Drayton Service ranges from the designing and installation of complete instrumentation schemes to the supply of single regulators for a particular process. Send us details of your problem or write for the Drayton Catalogue covering our manufacturing range.

*and get things under control

Write to Dept. P.

AC29

The Drayton Regulator & Instrument Co. Ltd., West Drayton, Middlesex. *Tel.: West Drayton 4012*



LOW-STATIC LUSTREX ends the problem of dust attraction: electrostatic charges are so reduced that unsightly dust patterns do not form. Low-static Lustrex is the ideal moulding material for counter displays . . . cosmetic containers . . . packs for consumer goods — in fact, for use wherever display appeal counts. It is available in both general purpose and toughened grades.

LUSTREX T7 is an entirely new grade of toughened polystyrene. Yet although toughened—impact strength 0·7 ft/lb. per inch of notch — it produces mouldings with a gloss almost as good as General Purpose Lustrex. Lustrex T7 is therefore ideal for use where a good surface finish has to be combined with extra strength.

LUSTREX UVL resists yellowing on exposure to ultra-violet light. It has been specially developed for the moulding of interior light fittings for use with fluorescent lighting. Compared with metal or glass, Lustrex UVL offers the special advantage of lightness in weight and ease of moulding into intricate shapes. It is available in crystal clear form or translucent white, also in colours.

These three new grades of Lustrex are further examples of Monsanto research in action — research that goes on constantly both to produce new chemicals and plastics, and to improve those you already use.

Write for more information on these new grades of Lustrex.

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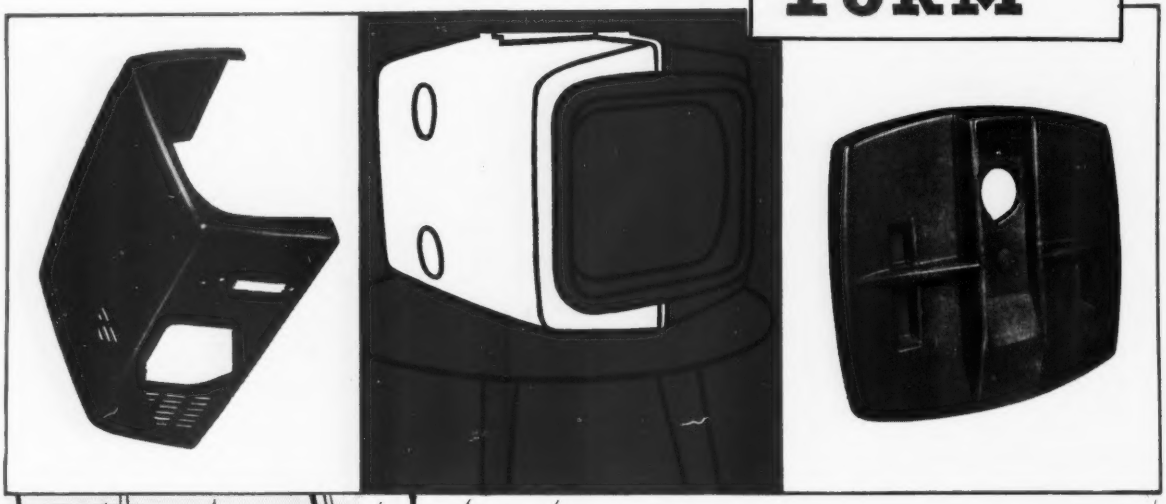

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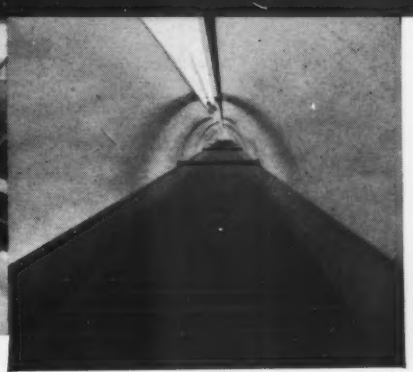

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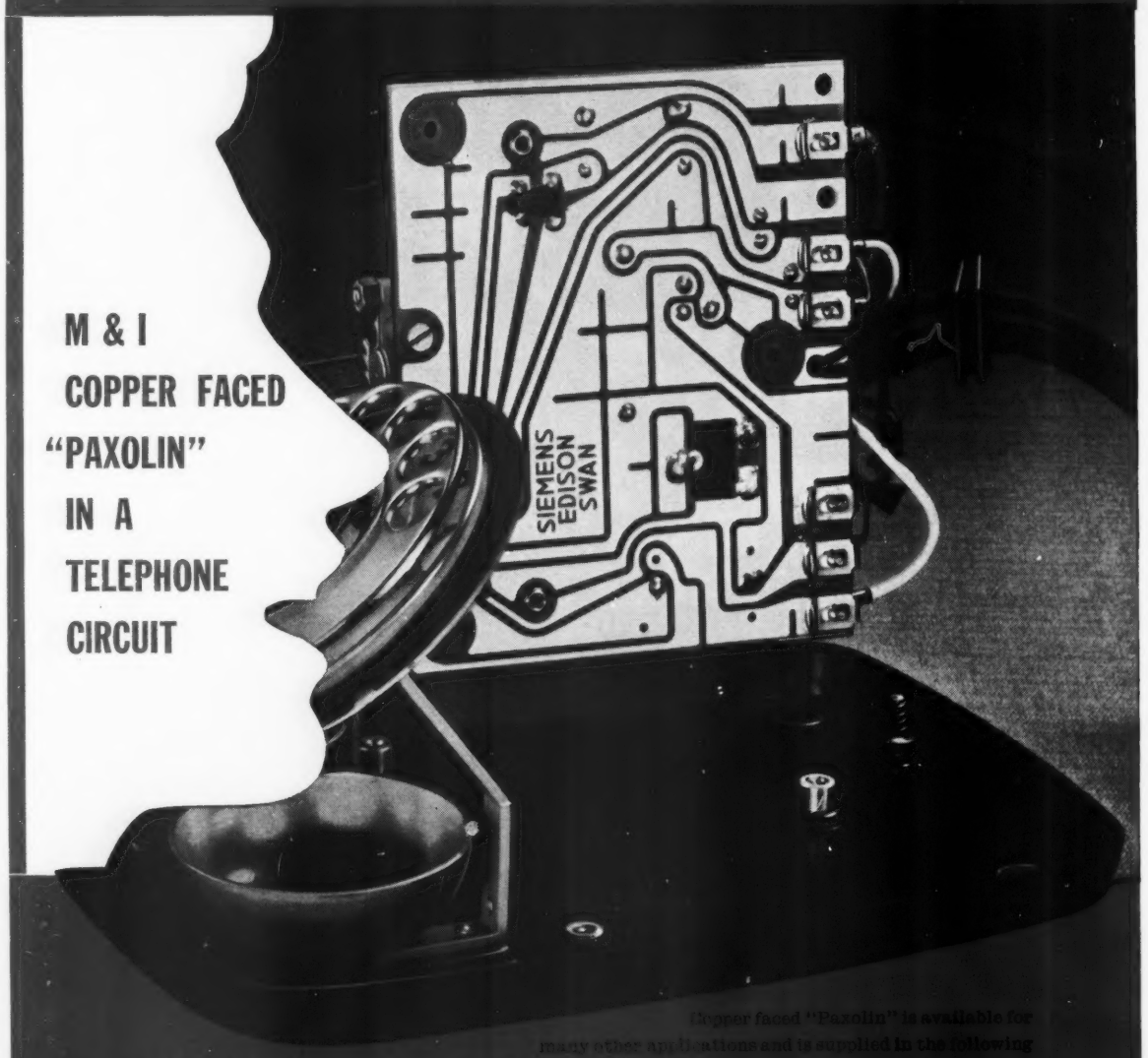

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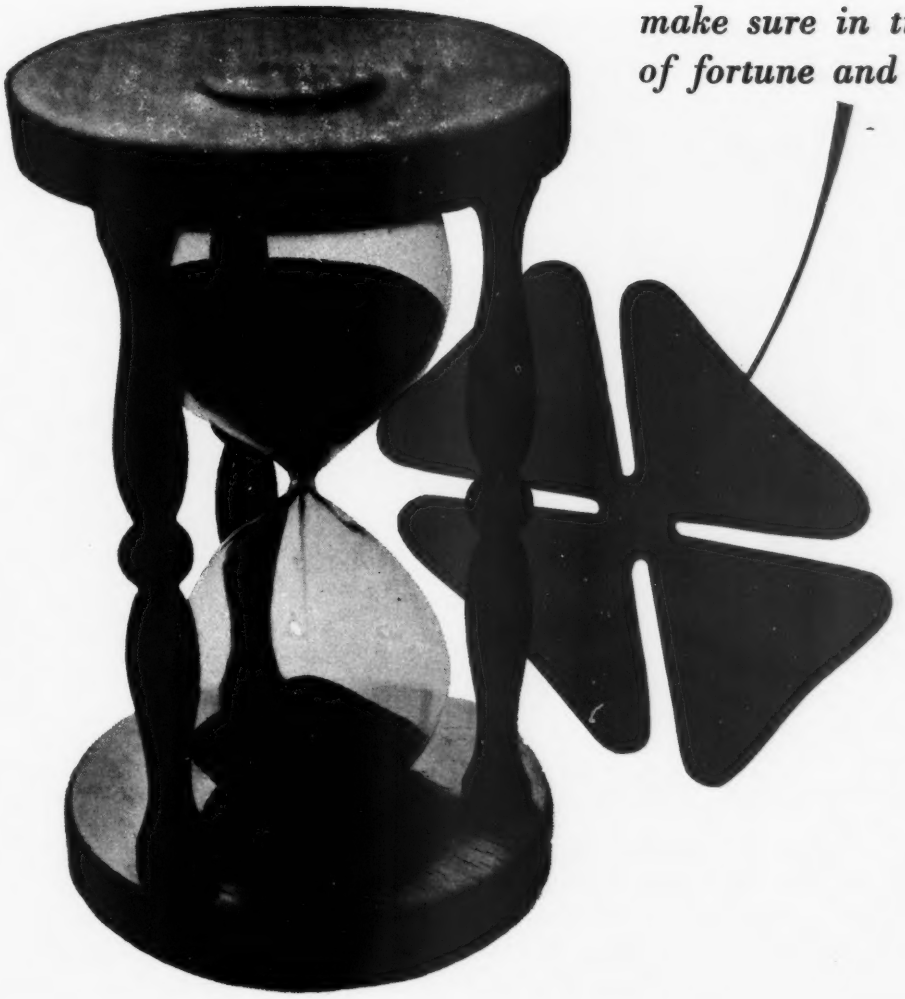

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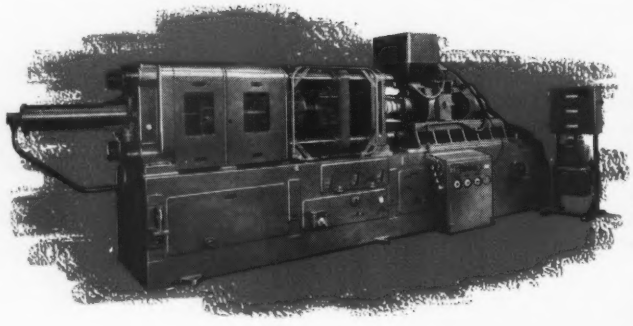

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Plastics

DEALING WITH THE MANUFACTURE, USES AND POTENTIALITIES OF PLASTIC MATERIALS

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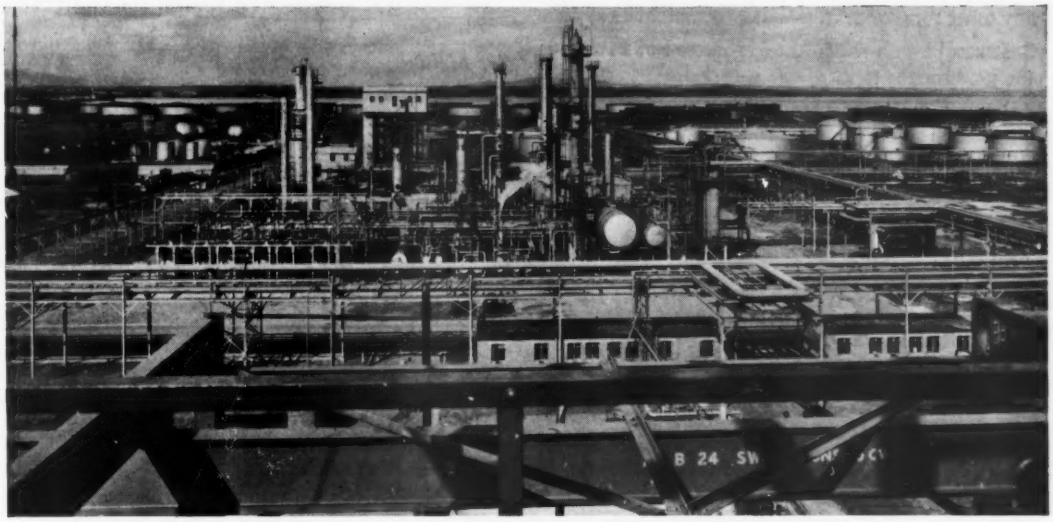

View of the British Hydrocarbon Chemical Company's plant at Grangemouth, Scotland. In the foreground is the butadiene plant, with the tetramer plant behind.

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Electrical Aids in Industry

Data Sheet **No.1**

Electro-Heat

The ways in which electricity can be used to advantage in industry are many and varied. Some are well known but others are not known well enough. For this reason the Electrical Development Association has prepared a series of detailed data sheets on various applications which will be printed in this journal from time to time.

This Data Sheet is the first of a number devoted to electro-heat—that is, heat produced by electricity for the processing and treatment of materials. Other uses will be dealt with later on in the series.

There is an unalterable physical law that the efficiency of conversion of *electrical* energy to *heat* energy is 100 per cent. The same cannot be said of the efficiency of combustion of any solid or liquid fuel.

All the applications of electro-heat have these advantages in common :—

1 Electro-heat is clean both in regard to its application and the method of generation.

2 It can easily be controlled more precisely than any other form of heat, manually or automatically.

3 It can be brought to the job instead of having the job brought to it.

4 It permits better use of floor space and the elimination of unnecessary handling.

5 In many of the newer processes it is the only possible form of heat which can be used.

6 It often ensures a higher quality of products with fewer rejects.

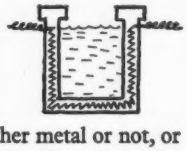
7 It gives the best working conditions.

8 It reduces or eliminates fire and explosion hazards.

Below will be found brief notes on some of the various methods of generating heat by electricity.

Resistance Heating

This is the best known form of electric heating. The elements provide a high resistance to the passage of electricity and thus heat is generated. It can be used in furnaces for melting or heat treatment of any material whether metal or not, or the resistance of the workpiece itself can cause the generation of heat.

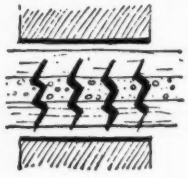


Induction Heating

Eddy currents are induced in the surface of a conducting workpiece, heating it up. The depth to which this heating will penetrate is determined by the time it is given.

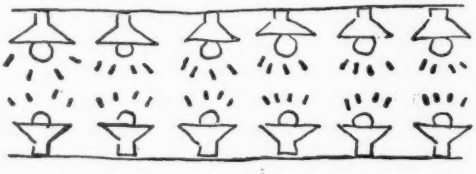
High-frequency Dielectric Heating

This form of electro-heat can be used only on non-conducting materials such as wood, plastic and rubber. The material is placed between two electrodes to which a high voltage is applied at a high frequency. This has the effect of generating heat inside the material rapidly and uniformly throughout its entire thickness.



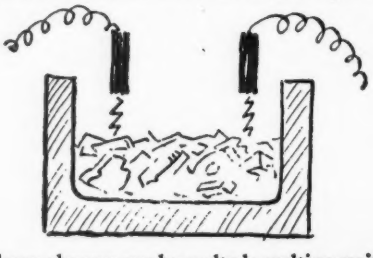
Infra-red Heating

This method employs pure radiant heat. The bulk of the radiation takes place in the infra-red portion of the radiation frequency spectrum. The heaters may take the form of reflector lamps or sheathed wire elements. The method is extremely flexible and has many uses, including paint drying and pre-heating plastics.



Arc Melting

This form of heating is chiefly used for melting steel. The diagram illustrates one method of operation.



Very large charges can be melted; melting units of 200 tons capacity are now in operation.

The Application of Electro-Heat

All these methods of electric heating can be applied in almost an infinite variety of ways. Some of these ways will be dealt with in subsequent sheets.

For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2.

Excellent reference books on electricity and productivity (8/6 each or 9/- post free) are available—"Induction and Dielectric Heating" is an example; "Resistance Heating" is another.

E.D.A. also have available on free loan a series of films on the industrial use of electricity. Ask for a catalogue.

Plastics

VOL. XXIII No. 254 NOVEMBER, 1958

EDITORIALS

Transport—and the Market for Plastics

THE Autumn of 1958 may well go down in history as a landmark in the growth cycle of the plastics industry. In October, London saw the Commercial Motor Show, the Motor Show, and at Brighton a record Federation Conference was convened to discuss reinforced plastics. This month, the Comet 4 commences scheduled flights to the U.S.A. All these events are linked for us by a common theme—the role of plastics in the field of transport. It is this aspect of plastics utilization that this issue of *Plastics* sets out to underline.

To gauge the full implications of the Comet 4 as a transport application, one has to see it and fly in it. It is a magnificent machine, a brilliant example of all that is best in British aeronautical engineering. It is also a classic worked example of what plastics can do when circumstances dictate.

In this issue we devote seven pages to an analysis of the contribution of our industry to the Comet 4. By any yardstick it is impressive for there is hardly a plastics material currently made that has not found application in some form or another. Reinforced plastics, Perspex, p.t.f.e., epoxides, p.v.c., polystyrene, polythene, phenolics, all are involved. When it is remembered that each and every one of these materials was evaluated in the most critical terms for the job it had to do, and that the applications range from high-duty wiring to wall panelling, our cause for pride in our products is in no sense misplaced.

What may not be so readily apparent is that apart from the obvious advantages of lightweight and appearance, these plastics applications have been designed into a passenger vehicle which has to undergo extremely heavy use. Last year a small number of aircraft carried across the Atlantic almost as many passengers as did the big ships. People are constantly getting in and out of aircraft, and the wear on furnishings and cabin equipment is extremely high.

This exercise in design has not gone unnoticed in other areas, however. If plastics have been able to make such a contribution to the Comet 4, what of the automobile, the bus, the ship, and the railway carriage ?

The automobile manufacturers are already in close touch with the plastics industry and we may cite, as an example, the " new look " designed into the new Rover 3 litre car, where phenolic mouldings are employed so elegantly in the instrument panel and the steering column shroud. A report on this project, which involved a tool cost of over £20,000, is given on page 401 of this issue. If Mr. Rajan's comments are followed up (*Plastics*, April, 1958, page 115), the automobile industry should provide us with a rapidly expanding market for our goods.

In other forms of transport too, the outlook is equally promising. The Brighton conference of the British Plastics Federation, also reported in this issue, provided a platform for many technologists in user industries to state their requirements and problems to the assembled experts in reinforced plastics. The resin-glass ship's lifeboat is already a success story, and a representative of the British Transport Commission was hopeful of wider applications still in goods vehicles. The representative of Vickers reported that in the first Viscount there were 88 polyester-glass components, in the larger and newer version there were 715, and in the Vanguard 1,400. Another speaker referred to a recent shipbuilding analysis which showed that in a vessel of 40,000 tons, 1,000 tons could be saved by the use of reinforced plastics for cabin bulkheads, bathroom installations, superstructure items and others. Indeed, the conclusions which are valid for the Comet 4 are valid for ships and for all forms of transport; by using plastics it is possible to save weight, to provide greater durability, to improve appearance and, in many cases, to save money.

Acceptance of plastics by the transport industry, whether on land, on sea, or in the air, depends on one vital factor—our ability to offer accurate and comprehensive details of the performance of these materials under all reasonable conditions, their strength properties, their electrical characteristics, their resistance to fire. With some plastics materials these facts are already fully elucidated, with others a great deal remains to be done.

The sooner, therefore, that we can fill these gaps in our technical sales catalogues, the sooner shall we be able to press home our advantage and obtain for plastics a key position in the transport field. The pattern of development is already clear.

Education—the Industry Speaks

THOSE in the plastics industry who have recognized the dilemma we face in the matter of adequately trained technologists will take heart from the letters we print on pages 404 and 405 of this issue. Only pressure on the available space prevented there being four instead of two pages devoted to comments by leaders of industry and education, who have responded to the Editorial which appeared on this page last month. We shall be publishing further letters in December.

Whatever course events may take in the educational sphere, at long last a base line has been established for all to see. Sandwich courses and part-time day release courses are as important to the future of our industry as fundamental research is important to the materials manufacturer or improved processing plant is to the fabricator. However great the difficulties may be, we *must* face and solve the problem.

Fortunately, we now have some tangible suggestions for helping to demolish a few, if not all, of the difficulties. Dr. Swallow argues that the availability of adequate grants, free from means tests, would go a long way to meeting the situation's needs. Mr. Kaufman asks for a directive from the industry as to what its requirements are in the matter of trained staff. He suggests also courses of one year for selected graduates, to supplement their basic training with a special course in polymer technology.

With these, and with the other suggestions put forward, we unreservedly agree. Further, we hope that the words of Mr. Cyril Dingley, when he refers to the element of competition which our own plastics industry now faces, will cause the forthcoming meeting between the British Plastics Federation and the Plastics Institute on this topic to be charged with a sense of urgency.

The first requirement is to define exactly what the industry needs, and this only the industry itself can do. The second is look at our present courses and syllabuses, against the industry's directive, and to re-align them if necessary. The machinery already exists, in the Institute, the Federation, and the Education Fund.

MOULDING POWDER AND SHOT

I went to a remarkable show the other day organized by Storeys of Lancaster. A large hall in a London hotel had been completely hung in a multitude of patterned p.v.c. sheets.

Storeys Success Story

In six short years Storeys have made gigantic steps forward to the point today where they have established an unrivalled position in the field of decorated plastics sheeting. Dr. David Harper gave a short account of the long association of Storeys with the flexible sheeting industry and underlined the company's special strength in the design field. He has reason to be proud of what has been achieved.

* * *

With the grim purposefulness of the true American " craze," hula-hooping broke out somewhere in the Union between the Pacific and the Atlantic, and by the end of September had

Hula Hoops—Hooray!

caught the Deep South, the Middle West, Narragansett, Oshkosh and Pendlebury (Mo.) fast in a rhythmical mystic rite. Encircled by plastics hoops, Americans gyrated with all the fervour shown by their yo-yo twiddling mums and dads in the 1930's. And now, with polythene manufacturers going mad to find enough material, and extrusion machines burning out big ends so fast are they working, the extruded polythene hula hoop is here in England, too. My particular hoop, coloured yellow, to go with the egg-stains on my tie, has a diameter of 3 ft. Not being as loose-limbed as I was, I cannot hoop with the same aplomb and grace as the young lady seen in the photograph below. I can, however, tell you that in each hoop there is 113 in. of extruded polythene tube, with a diameter of $\frac{3}{4}$ in., and that if the craze persists, and every indication suggests that it will, extruders are in for a fine time. My photograph shows a hoop of Rigidex, British Resin Products' high density material.

A packaging revolution may well be initiated by the introduction soon of the Cubitainer, a package system that comprises an outer corrugated cardboard cube which supports, and

Packed in Polythene

protects, an internal, semi-rigid polythene container. Already in use in the U.S.A., where they were developed by the Hedwin Corporation, the Cubitainers will be available in five gallon, one gallon, and one quart sizes. The formed polythene cube has a lip for filling and pouring. When filled, the lip is heat sealed, and the contents, whether liquid, powder, or semi-solid, are safe from contamination. Iridon Ltd., one of the Commercial Plastics group of companies, have acquired an exclusive licence to manufacture and sell Cubitainers.

* * *

At a cocktail party in London last month, Arthur G. Dennis, chairman of the Windsor group of companies, announced the acquisition of Webley & Scott Ltd., the famous gunsmiths and

News from Windsor's

engineers, by R. H. Windsor (Holdings) Ltd. By this move additional production capacity will be made available for the range of Windsor extruders and injection moulding machines. The news came on the eve of the departure for Moscow, Warsaw and Prague, of Greg Windsor, the company's managing director, who took with him a film which we were able to see as well. Shot in the Chessington works, the film shows the design and construction of the company's range of machinery for the plastics industry, and runs for 15 minutes. The commentary, and herein lies perhaps one of the reasons for Windsor's outstanding sales success abroad, is in Russian. And so are all the specifications and sales catalogues that Greg has distributed during his three-weeks' tour. As I watched the film, and listened to the enthusiastic comments of other viewers, I thought of the " guv'nor," R. H. Windsor himself, and how much he would have approved of this get-in-and-sell approach. For wherever there is business to be done, Windsors are there.

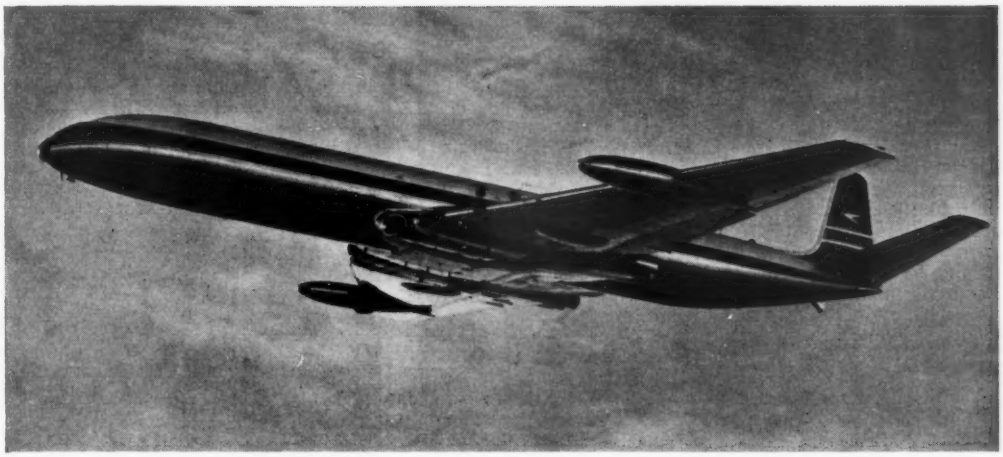
* * *

Numbered amongst the more peculiar characteristics of this country are the symbols " £.s.d." Twelve pennies to the shilling, 20 shillings to the pound, and you need a pocket ready-reckoner

Moments About A Point

to keep the situation under control. Readers of this column may not realise it, but the stark fact remains that we are rapidly becoming so exclusive in our currency system as to place ourselves, in fiscal history, somewhere near the Great Auk. A commission set up in South Africa in 1956 has just reported in favour of a decimal currency for the Union and in New Zealand and Australia there is strong sympathy for a similar reorganization. If this happens, the United Kingdom will be left, for all practical purposes, with a unique currency system, lonely in the great sea of francs, marks, dollars, kroner, lira, roubles, and all the rest of the doubloons that come in neatly divisible units of 100. The rub is two-fold; how can we expect to remain one of the chief pivots of world banking and finance as long as we cleave, however patriotically, to our clumsy and illogical system, a system that causes the Continental to rave frenziedly until he subsides into gales of laughter at the 240 pence pound. Again, if the rest of the world is right—and most foreign currencies now are decimal ones—how can we willingly perpetuate a currency system that is manifestly costly to operate ? South Africa calculates that it will cost £10m. to convert to a decimal system. It might cost us £100m. to put ourselves at a tremendous advantage at home and in a position of parity abroad. Bring in the decimal point and, while we are about it, reform the weights and measures department as well.

DOGSBODDY



" I shall take flight as a bird wings into the infinite blue." (C. L. O'Donnell — " Immortality.")

COMET 4

THAT all Britain was proud when B.O.A.C. initiated the first pure jet transatlantic service with the Comet 4, there can be little doubt. The de Havilland Aircraft Company's faith in the Comet 4 was fully justified. It is now the turn of the plastics industry to be proud, for in the following pages we have attempted to show some of the many applications of plastics in this fine aircraft.

In the fuselage and wings of the Comet 4 plastics resins play an important part as can be learned from the article on Redux bonding appearing on page 396. In addition, glass reinforced polyester mouldings are used for the dinghy panels situated at the junction of the wing to the fuselage and for the elevator tip. The radome at the nose is of Terylene reinforced resin and the windows are of Perspex. Finally on the exterior of the aircraft are two machined nylon wheels housed beneath a rubber covering on the wing fuel tanks. The function of these is to give some support and control to the Comet should it be forced to make a landing with an undercarriage failure. Tests indicate that these wheels are tough enough to withstand two such landings before being sufficiently damaged to render them not up to standard.

It is on the interior of the Comet 4 that the greatest use of plastics can be seen and in addition there is much which is not apparent to the passenger. Air ducts and air conditioning plant, fan housings, roof linings, luggage receptacles, water piping, cable cleats, cable covering, electrical gear, and oxygen equipment, are some of the many applications. The development work that has been carried out with reinforced plastics, to make possible many of these applications, is of considerable interest, and has added greatly to the sum total of knowledge in this specialized sphere.

The furnishings and fittings of the passenger cabin, pantry and toilets are almost exclusively in plastics and the tasteful decor designed by Gaby Schreiber for the B.O.A.C. fleet utilizes these materials and their properties to the fullest extent.

In the September issue of *Plastics* we described these interior decorations and we do not propose to repeat what has already been said. It is sufficient to say that the companies whose materials have been used can be proud of their contribution to this aircraft.

This indeed can be said of all the companies in the plastics industry who have, by their " know-how " and skill assisted in the production of the Comet 4. Not the least amongst these is the plastics division of the de Havilland Aircraft Co., and de Havilland Propellers, especially the latter where new techniques have been developed, one of which is described on page 395.

Although in weight or quantity the plastics used in Comet 4 are a small drop in a large ocean the prestige value of this " drop " is enormous and we are proud to be able to show in the following pages some of the applications and in so doing, to tell the world how the industry we represent has contributed to the most modern passenger jet airliner of today.

Skilled work by a de Havilland technician in the manufacture of the randome which is of polyester resin reinforced with Terylene.

COMET 4

Plastic Components Employed

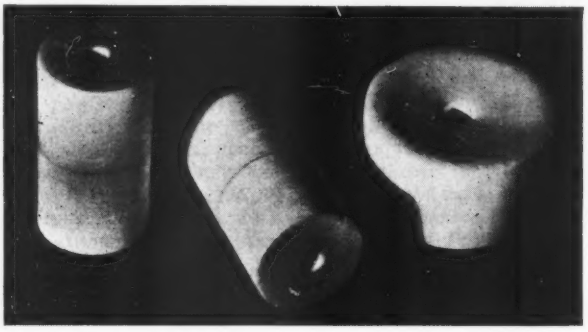
THE range of plastics materials used in the Comet 4 is one which embraces the majority of plastics available today. Ranging from p.t.f.e. tubing to phenolic fuseholders it includes sheeting, laminates, mouldings, extrusions, formings, machined parts, and foamed materials. In fact it can truly be said that de Havilland Company has used the resources of the plastics industry to their full extent.

Although many of the components are manufactured under contract, de Havilland Aircraft have an extensive plastics shop of their own and it is in this plant that a lot of the fabricating is carried out. Such components as the radome which is a laminate of Terylene reinforced polyester resin, the air ducting, dinghy panels, and other panels, as well as the lining for the canopy roof and luggage bay, all of which are glass fibre reinforced polyester, provide some indication of the work carried out in this field. In addition to the laminating processes, much of the forming is done by de Havilland. The interior window surrounds are formed from I.C.I. Plastics Division's Darvic p.v.c. sheet as also are many of the fittings and end panels in the toilets. In Perspex, manufactured by I.C.I., the door pelmet provides one example of the use of this material, but more important are the windows, the construction of which is undertaken in this shop. These windows are of a sandwich construction. Two sheets of Perspex approximately 1 in. to 1½ in. thick are cut to size and suitably machined. They are then moulded to conform to the contour of the fuselage and afterwards the inner sheet has an air circulating fitting attached. The actual sandwich consists of an outer Perspex sheet to which is cemented a rubber ring or gasket and on top of this is cemented the inner Perspex window. The join is reinforced by a glass fibre mat. The gap between the two parts of the window thus formed has dry air circulated through it to prevent misting.

The electrical equipment of the Comet 4, as one would expect, uses plastics extensively, phenolics, alkyds, p.v.c., polythene and polystyrene all playing their part in the safety and operation of the aircraft. As an indication, there are 736 components in the Comet 4 manufactured by Belling & Lee Ltd. These include fuseholder heads moulded in phenolic material.

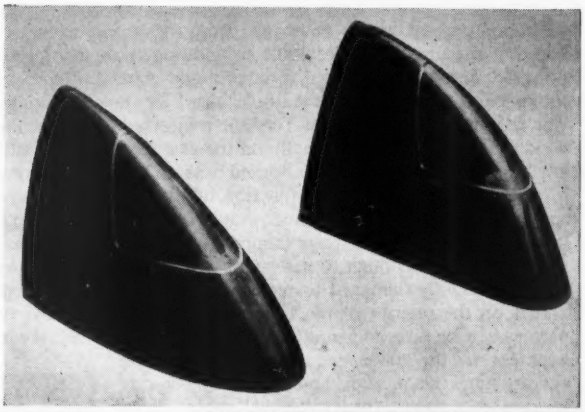
Insulation Equipments Ltd. is one of the firms in the plastics industry which have produced details for the Comet since the earliest days of the Comet Mark I. Indeed, this company have for many years specialized as fabricators of laminated plastics and are recognized to be one of the leading organizations in this particular field. de Havillands have entrusted to them the manufacture of several hundred different components of various types, most of which are precision machined to fine limits from the well-known Bakelite range of fabric based and paper based sheet, rod and tube materials. These components include fairleads, clamp blocks, insulators, bushes, cable seals, rollers, housings, special wheels and many others, all of them machined to the exacting standards set by the aircraft industry and the Air Registration Board. Extensive use is made of Cobex Velbex sheet, by B.X. Plastics Ltd., for leg panels, etc.

Two applications of foamed materials are of interest, the first the use of polyurethane foam, supplied by Sorbo Ltd., for upholstery, and the second the use of foamed rigid p.v.c. for the vent valve floats in the fuel tanks made from "Fi-Vi," manufactured by Whiffen & Sons, Ltd. The p.v.c. is completely unaffected by immersion in the fuel.



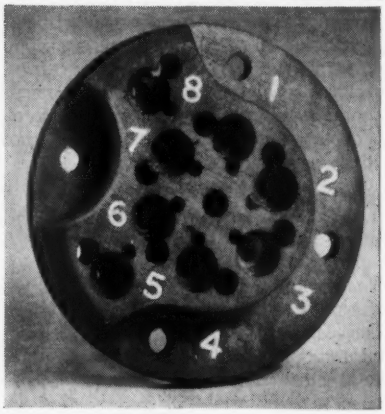
(Left) "Fi-Vi" cellular rigid p.v.c. vent valve floats, used in the fuel tanks. "Fi-Vi" is unaffected by continuous immersion in fuel and is ideal for this application.

Window surround being vacuum drawn in Darvic.



(Right) Fairings made in polyester-glass materials to high performance requirements.

Fuseholder, employing phenolic materials, manufactured by Belling & Lee Ltd.



Terminal block made from laminated material by Coin Insulation Ltd.

(Right) Cabin ceiling light cover being drilled.

An extremely arduous application although one which it is hoped it will not be called upon to perform is the use of nylon for the forced landing wheels recessed in the pod tanks on the wings. The wheels are machined from blanks supplied by Polypenco Ltd., and the type of nylon used is L grade, which has a high impact strength.

We have already mentioned many of the interior fittings, but one application of great importance not mentioned so far is the use of polythene tube for water piping. This tubing is supplied by Tenaplas Ltd. and the final assembly of the system is carried out by de Havilland.

In the furnishing of the passenger cabin extensive use of plastics sheet has been made. Jas. Williamson & Son, Ltd., supply specially fire-proofed coated fabrics for use as linings on walls, ceiling and bulkhead, and also as flooring in the pantry, sub-pantry and lavatories. Wallington Weston & Co., Ltd., also supply an unsupported sheet which is used for the quilting on the entrance door and walls of the sub-pantry.

Finally there is extensive use made of Formica and Warerite decorative laminates in the pantries and the passenger cabin.

COMET 4

Plastics for Jigs and Tools

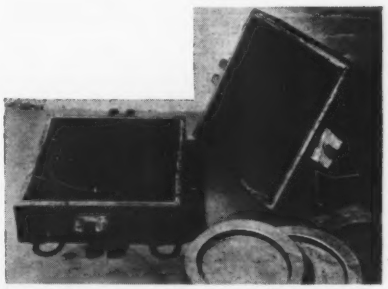
BESIDES the many uses of plastics in the aircraft itself there are several applications of importance in the tooling and jigs used in its construction. A selection of these, illustrating the variety of work to which plastics tools can be put, is shown in the accompanying photographs.

Press and drop hammer tools are manufactured by casting an epoxide resin on to a zinc-based alloy core. The core itself is made from a wooden pattern via a plaster cast from which the zinc alloy casting is produced. It is not our intention here to describe in detail the manufacture of these tools but some facts about their operation may be of some interest. The press tool illustrated on the right has been manufactured by this method and is used for pressing the ice observation window frame from 18 s.w.g. Alclad. A larger tool of similar construction is used by de Havilland for pressing the flame shields for the engine bays of the Comet. The shields are made from 28 s.w.g. Alclad.

It has been found in practice that for pressing blanks of 20 s.w.g. or thinner gauge material, with this type of tool no allowance need be made for metal thickness. On larger tools the self-lubricating properties of the resin result in high quality pressings without any sign of tearing or undue thinning of the metal.

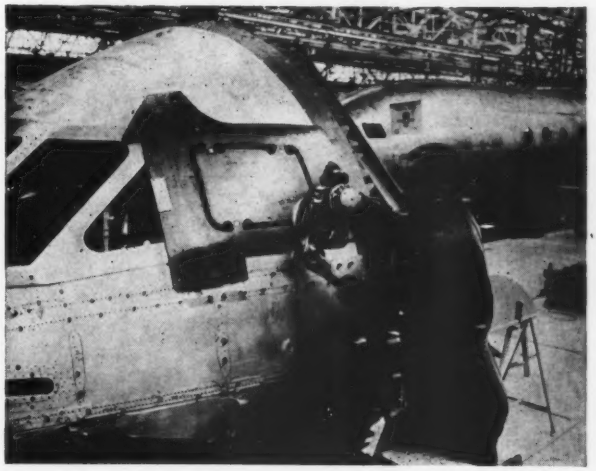
Jigs for drilling, routing and assembly provide a further example of the use of plastics. The routing jig is a straightforward laminate which by the method of its construction follows the contours of the aircraft to an exact degree. Drilling and assembly jigs are made up from epoxide/glass tube which is cut as required and then bonded by a further application of glass tape and epoxide resin.

Tools by Desoutter Brothers Ltd. are widely used with these drilling jigs.



A typical press tool faced with Araldite resin, used in making the ice observation window.

(Left) Drilling jig, the framework of which is made from epoxide/glass tube bonded with Araldite and glass tape.



(Right) A router jig made from Araldite/glass cloth laminate.

COMET 4

Phenolic Asbestos Materials

MANY of the mouldings for ancillary equipment in the Comet 4 have been fabricated from Durestos resinated asbestos materials which have outstanding physical characteristics. The applications include mouldings for air conditioning fan housings, cable ducting, coil formers and wire cleats. In de Havilland factories considerable use is made of Durestos for tooling purposes.

Marketed by Turner Brothers Asbestos Co., Ltd., of Rochdale, the Durestos range is available in felt, flock and powder form and is used for the moulding of components in a variety of industries. In the aircraft industry, these materials have been utilized for expendable drop tanks, radar scanners, and radar reflectors and are being considered for rocket blast tubes and venturi, guided missile wings and fairings.

A product moulded from Durestos is light in relation to its strength; it is heat and acid resistant and has dimensional stability.

Durestos felts, which are used in the manufacture of the fan housing described on page 395, consist of felted asbestos fibres, uniformly impregnated with a thermosetting resin to produce a pliable sheet which can be easily shaped to conform to the contours of irregular moulds.

In the manufacture of felts, asbestos fibres are orientated in one direction approximately 1½ times the strength in the traverse direction. The directional characteristic can be fully utilized by tailoring at points where the greatest stresses are likely to occur.

Because of this unique felted structure, mouldings which require some degree of flow in the mould, can be produced without filling corners and cavities in the piece with powders or short fibre moulding materials. Therefore the loss of strength associated with these materials is avoided. Felts may be moulded under any pressure although the manufacturers recommend a pressure of 560 lb. per square inch to obtain the maximum physical properties. High pressure, vacuum bag and no-pressure moulding techniques may be employed.

A range of flocks and powder was evolved because the intricacy of the shapes in which Durestos felts can be moulded is, naturally, limited. These materials are based on asbestos fibre or asbestos powder intimately mixed with a phenolic resin. All grades have excellent flow properties and can be moulded to practically any shape.

Although the physical properties of mouldings from flocks and powder are not as high as those obtained with felt grades, they are superior in several respects to normal phenolic moulding powders. Flocks have a relatively high impact strength.

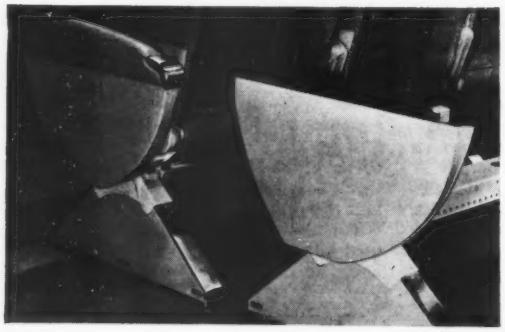
COMET 4

Passenger Seating and Plastics

A CONTRACT has been placed by BOAC with Microcell Ltd., of Kingsway, London. W.C.2, and Camberley, Surrey, to supply the whole of the passenger seats for the Corporation's fleet of 19 Comet 4 jet airliners.

Modern tourist seats are designed for absolute minimum weight, though as much effort as possible has been put into the design to provide comfortable travel. The trend is to develop very close pitching lightweight tourist seats in order to achieve a maximum passenger capacity for the aircraft. Particular care has to be taken to avoid having injurious protuberances, and all seats nowadays must be designed to withstand a crash landing of 9g with a test factor of 1.2, giving an ultimate strength of the seat structure of 10.8g.

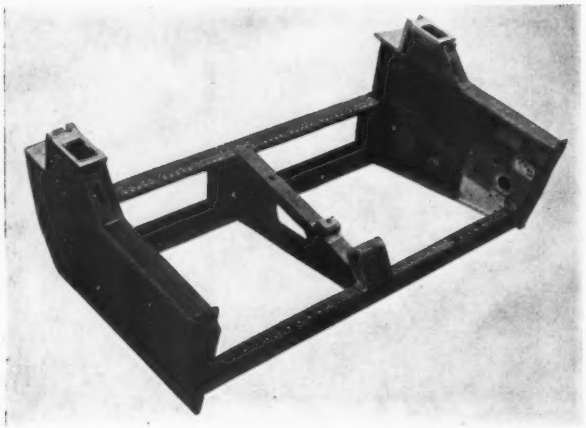
To achieve these aims Microcell Ltd. have employed plastics materials. The main frame uses glass reinforced polyester resin for the centre back pivot housing, the inner and outer panels on the side arms and the brackets in the side arms. Rigid vinyl sheet has been used as decorative removable covers for the side arm panels and legs in the tourist class seat. The result of these designs is an overall weight for the tourist class triple unit of 77. 3 lb. (double unit 55 lb.) and for the first class twin seat of 78.5 lb.



(Left) On the tourist seats rigid vinyl sheet material is used for arm and leg covering panels.

(Below, Right) The first class twin seat unit in the Comet 4.

(Below, Left) The first class seat frame which incorporates glass reinforced parts.



COMET 4

Moulding the Fan Housing

THE fan housing originally produced for the first Comet was a magnesium alloy casting. On the Comet 4 this has been replaced by a moulded housing made from Durestos felt, further details of which are given on page 394. The development of this and the moulding technique employed was evaluated by the Plastics Division of de Havilland Propellers Ltd. and the method described in the following paragraphs is both original and unique.

The advantage of using a Durestos housing, besides the saving of some 3 lb. in weight, is that there is no corrosion; the heat transfer from the housings to the bearing assemblies is much reduced, resulting in lower bearing temperatures under hot running conditions; and, better dimensional and weight control as compared with cast components is obtainable. This latter point caused some problems in the initial development of the housing, due to the close tolerances between a high speed impeller running within the moulding and a thin lip on the moulding. That this problem has been overcome is ample evidence of the technical superiority of the moulding technique.

The housing used on the Comet 4 is the larger of two designs both of which have been in service for a considerable period. It runs at temperatures up to 250° C.

Moulding Technique

The component is manufactured in one piece, using a temporary tooling technique developed by the plastics department. The principle involved is a parallel to the classic "lost wax process," and might well be termed the "lost alloy process," since the inside form of the component, and parts of the outside form where severe undercuts are encountered, are moulded against low melting-point alloy tools which are extracted from the moulded component by melting them away.

The lay-up employed, though lengthy, is as economical in both time and material as possible, and is readily applied by an experienced operator.

Components manufactured have been of a satisfactory and reproducible standard. Their specific gravity has been approximately 1.4, indicating a moulding pressure of about 15 p.s.i., i.e. equivalent to a vacuum moulding.

Although the technical advantages of Durestos over magnesium were anticipated, neither time nor production quantities justified a long development programme or matched metal tooling. All the initial quantities were in fact moulded using wooden moulds and plaster tools. The production quantities are being moulded in cast iron tools.

The first bore piece being wrapped with the glass fibre template in the foreground.

Temporary Tooling

For this moulding five patterns were required and these were produced from wood. From these patterns a stone mixture tool was cast by sealing the surface of the pattern with shellac varnish plying a silicone grease release agent and casting a stone mixture to form the tool. From these stone tools an alloy former is produced from alloy No. 315J supplied by the Hoyt Metal Company of Great Britain. This is done by heating the stone tool to 150° C. for two hours and pouring the melted alloy into it thus forming a reproduction of the original wooden pattern.

The five patterns are: Pattern A, a model of the outside form of the component, with the central bore removed. Patterns B and C, models of the central bore, which fit exactly into pattern A. Pattern D, a model of the inside form of the component. This fits exactly on to pattern C. Pattern E, a model of the outside form of the fan inlet from the volute to the flange on the fan inlet. This is in two or more parts, and fits exactly on to pattern A. Patterns A, B, C, and E, assembled together are used for the manufacture of the two-part outside forming tool for the component. Patterns B, C, D, and E, are used for manufacturing tools for casting alloy formers.

Having produced the five core pieces, it is now necessary to manufacture templates around which the Durestos felt is cut. Two of these templates which are flat are manufactured from Durestos felt, the third template which is of a complex shape is formed on a plaster core and comprises five layers of glass cloth impregnated with cold-setting polyester resin.

Laying-up

Having prepared the tool and the core pieces, the felt is cut out and laid up on the various internal cores. Some 170 pieces in 22 different shapes are cut and each one is laid-up according to a specific plan which takes into account the grain direction in the felt. The laid-up felts are consolidated on to the cores and moulds by rubber rollers. The complete tool is then assembled using, if necessary, a resorcinol compound as a lubricant. The component is then cured by maintaining it at a temperature of 120° C. for 8 to 10 hours. After this period the temperature is increased to 150° C. for a further two hours. The housing is then removed from the mould and placed in an oven for two to three hours at 180° C., at which temperature the alloy cores melt out. This second operation performs the dual purpose of giving a post cure to the housing. The next operation is impregnation of the moulding with an epoxide resin prior to rough machining. This is done under vacuum for two hours after which it is cured at 150° C. for eight hours, followed by 12 hours at 200° C. Rough machining of flanges which are not moulded-in is then carried out followed by a further impregnating process. This second process is again under vacuum followed by the cure times described above. Final machining to the very close tolerances required and painting, using a special epoxide base paint manufactured by Cellon Ltd., completes the manufacturing process.

Fan housing for Comet 4 in Durestos material.

The impregnating processes described are the key to the whole problem of maintaining dimensional stability over the wide temperature range at which these housings operate.

Quality Control

Apart from dimensional inspection, certain tests can be employed to ensure that a good moulding standard is being maintained. Suspected voids can be checked by the use of X-ray photographs as can the maintenance of accurate wall thickness.

It should be noted that under-curing is virtually impossible since it is not possible to melt out the alloy core without completing the cure.

Bottom tool lay-up showing wrapped first bore in position with alloy core on top and the wrapped core, again of alloy, ready to be placed on top again.

COMET 4

The Redux Bonding System

By R. A. BERRIDGE*

IN July, 1944, Redux first took the air in the de Havilland Hornet. The de Havilland Aircraft Company therefore have the distinction of being the first aircraft manufacturers to use the Redux bonding process as a means of fabrication. This process, used on the Hornet to bond wood to metal on the spar and on the ribs, was developed further on the all-metal Dove and Heron aircraft to bond the stringers to skins throughout the wings and fuselage. The Dove went into production shortly after the end of World War II, and approximately 500 of these aircraft were built employing a total of 22,500 bonded parts. As in the Dove, but on a more ambitious scale, adhesive bonding is employed extensively in the structure of the Comet.

The initial development and production of Comet aircraft was inaugurated with no more financial help than an order from B.O.A.C. for 14 machines and for two from the Ministry of Supply. Such was the faith in the design of the aircraft and in the Redux bonding which makes an indispensable contribution to its success. A remarkable feature in the execution of this design was that it was taken into production straight from the drawing board, without the delay incurred in the building of a prototype. Investigations leading to this high level of acceptance of adhesive bonding as a process employed on essential structural components had of necessity been exhaustive. Typical investigations included the effect on joints of repeated alternation of temperature between 80° C. and −50° C., the effect of repeated alternations of loading at these temperatures, and the resistance of bonded joints to aircraft fuels, hydraulic oils and de-icing fluids. In the shops a system of process control and inspection was in operation which ensured a smooth flow of bonded components to a satisfactory standard. Problems due to the increased size and thickness of components used on this aircraft existed and were successfully overcome by new techniques in bonding and tooling. The absolute test of a process of this type is found in actual service experience and no evidence of any failure due to bonding in previous aircraft had ever appeared.

The Redux Process

Very briefly, the process uses a thermosetting phenol formaldehyde resin in conjunction with a polyvinyl formal powder. This powder is a strong plastic material giving toughness and shock resistance to the combination whilst the phenol formaldehyde provides the wetting properties essential to adhesion and also acts as a partial solvent for the polyvinyl formal powder.

In practice the resin is applied to the prepared surfaces followed by an application of the powder. The joint is then closed and both heat and pressure applied. The temperature required at the glue line for the curing process is 145° C.–150° C., pressure being applied by means of a press or autoclave. The de Havilland Aircraft Company is perhaps the strongest advocate of press bonding in the aircraft industry. Beam presses (Fig. 1) are used extensively for bonding stiffeners to skins, the largest being 35 ft. in length. In this type of press heat is supplied by steam through the bore of the tools and hydraulic pressure applied at the base of these tools. For rapid cooling water is pumped through these bores before the hydraulic pressure is released.

Design Considerations

It may be asked whether in the manufacture of the Comet, adhesive bonding has been employed merely as an alternative method of fabrication to the conventional riveting as a saving in production costs or whether there are any other advantages to be gained. The answer would be, that whilst it is generally accepted that production costs can be expected to be reduced, the advantages lie in the performance of the final product. Low overall weight in relation to payload, increase in fatigue life, smooth external finish and simplication of design are features which will contribute to the success of the modern jet aircraft. The pure jet engine is inefficient at speeds greatly below 500 m.p.h. The Comet will therefore be operating at speeds such that skin surface irregularities would be highly detrimental to performance. How Redux bonding has contributed to this finish and the above features with its influence on design may best be seen by examining the main components of this aircraft in detail.

Fuselage Structure

The fuselage shell employs a 19 G. outer skin stiffened by longitudinal closed section stringers. These stringers are bonded to the outer skin throughout the fuselage over both the parallel and double-curvature portions. Whilst the application of heat and pressure necessary to effect a bond is a straightforward procedure for these panels over the parallel portion of the fuselage, the nose section involves double curvatures. The methods employed to bond the nose sections are unorthodox and of great interest.

A fuselage nose plaster model is made, accurate to within $\frac{1}{32}$ in., which incorporates a series of grooves representing the exact position of the stringers (Fig. 2). From this model a pair of loose cappings are made for each stringer position. These cappings are used in conjunction with a master consisting of a hollow Duralumin extrusion formed to the average curvature of the fuselage nose. In this manner only one master is required which when used with variations of cappings can effect all the bonding on the nose section. To produce the variations in the cast face of the capping a low melting-point alloy is cast with the hollow extrusion and capping mounted against the plaster model such that the nearest part of the unit is about half an inch from it whilst the extremities are an equal distance away from the model. The gap between the tool and plaster model is filled with low melting-point alloy which keys to the dove-tail in the capping. The bottom of the gap between tool and plaster is made with fireclay on a plywood support. Since these tools are operating at 145° C. during the curing cycle and to ensure accuracy at this temperature, the hollow extrusion and capping is maintained at this temperature during the casting operation. A series of tools is produced in this manner and it is a simple matter to

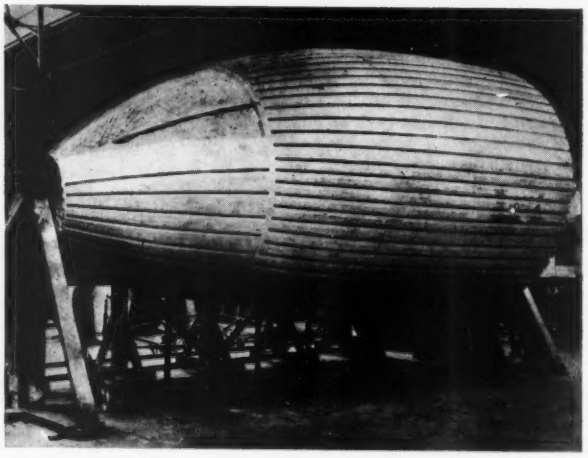


Fig. 2. The plaster model for the nose section.

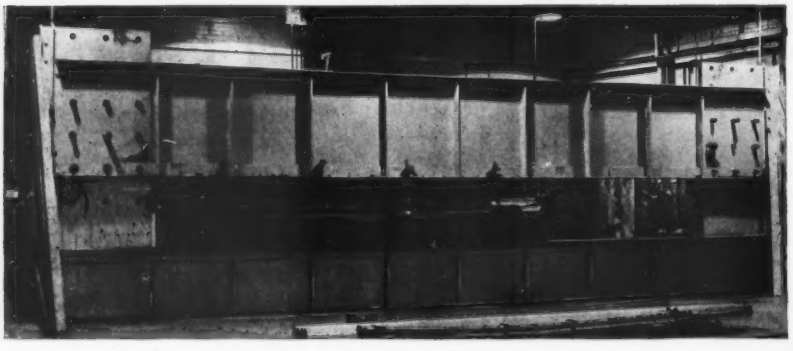


Fig. 1. A 25 ft. beam press showing a stringer being bonded to a section of the fuselage skin.

* Ciba (A.R.L.) Ltd.

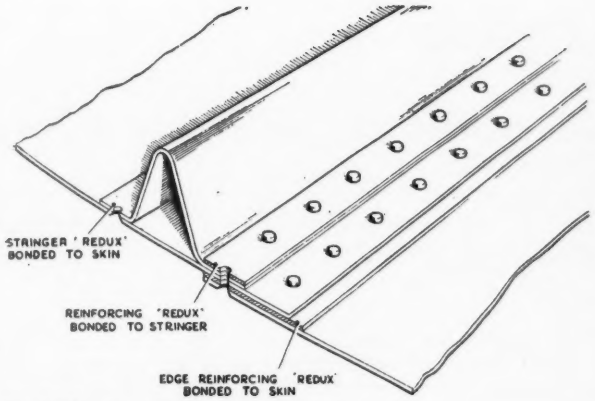


Fig. 3 (Above). A typical skin joint.
Fig. 4 (Right). Section of wing skin and stiffeners.

change the capping for the bonding of each individual stringer.

A series of fuselage panels some 22 ft. long is produced in which all the stringers are bonded to skin. These panels are formed into one large skin by riveted lap joints, a typical joint being made up as shown in Fig. 3. In order to achieve an efficient transfer of load without high stress concentrations careful attention has been paid to the design of these joints. A reinforcing strip has been bonded to one flange of the stringer and also to the edge of the connecting skin. Riveted skin joints such as this have been subjected to an average of 196,000 reversals of load without failure and even those specimens lying at the lower end of the scale have exceeded 14 times the normal life of the aircraft.

In this manner a fuselage skin is produced ready for attachment to the frames. The necessity for jig drilling the rivet holes in the skin and in the stringers has been almost entirely eliminated, together with difficult and expensive techniques such as grinding rivets flush to produce a smooth outer surface. Since almost the entire fuselage is pressurized the problems involved in sealing rivet holes and joints have been largely eliminated using a bonded construction.

As mentioned earlier, a low structure weight is of prime importance to the efficiency of an aircraft when related to operating costs. For a given all-up weight the saving of structure weight can represent very appreciable increase in payload, and it has been stated that every pound of weight saved is worth about £50 sterling a year. This saving is even greater when operating a pure jet like the Comet. Panels have been tested representing the fuselage stringer-skin combination subjected to compressive loading. Specimens of equal weight and dimensions have been constructed and tested to show a considerable increase in strength when stringer attachment has been made by bonding as opposed to riveting. It would appear that the principal factor contributing to the added strength in the bonded stringer-skin combination is the continuity of contact or the avoidance of inter-rivet buckling which can be the source of premature failure in a riveted structure. In cases where the rivet pitch is wide the strength difference is even more marked. When a bonded panel is progressively loaded, failure develops from some region of instability, but parting of the bonded joint is never the criterion. In using a bonded type of construction the de Havilland engineers have produced a fuselage of exceptional strength in relation to the weight. The saving in weight of the rivets which would have been used is in itself substantial.

Fuselage Cut-Outs

Wherever cut-outs such as windows and access doors occur in an aircraft fuselage, there are concentrations of stress. The designer endeavours to keep his cut-out areas small in order to keep the level of stress as low as possible but at the same time he must provide an aircraft which from the passengers' point of view provides a window with good visibility, and from the operators' point of view, freight doors as large as possible.

These conflicting requirements have been met in the construction of a window. The method of bonding doubling plates to the skin and window frame typifies how, by carefully grading and reinforcing the structure at windows, doors and other cut-outs in the fuselage, the stress level at these positions, which are normal sources of fatigue, is reduced to a point where fatigue cracks are unlikely to form. Tests on components of the Comet fuselage have shown that factors of over six on the life of the aircraft are achieved with no cracking. Further, if a crack begins near a cut-out and is not repaired the aircraft would still have a life of six times its normal service life.

In recent years the aircraft designer has had at his disposal aluminium alloys of high static strength. These alloys, however, have very poor fatigue resistance at high levels of stress. Conventional methods of construction such as riveting, spot-welding or bolting present local areas of high stress where the components are " stitched " together. By using a bonding technique the de Havilland engineers have maintained a level of stress at these window cut-outs which ensure a fatigue life well beyond the expected operational life of the aircraft. A 29 ft. long fuselage section with specimens of every type of cut-out included has successfully undergone 120,000 reversals of pressure in the water tank without a major failure of any sort. On the assumption that each reversal simulates a three-hour flight, and with a scatter factor of six applied, this represents more than 60,000 hours flying or 20 years of airline service.

Wing Structure

Extensive use is made of adhesive bonding in the wing of the Comet. The spanwise stringers are attached to the skin over the whole of the top and bottom wing surfaces by this method. These heavy section stiffeners are bonded to a skin which in places is more than one tenth of an inch thick. A typical section is shown in Fig 4. This represents in effect an integral section made without recourse to the expense and waste of milling from the solid which is an alternative method of producing heavy stiffened panels.

Extensive sealing of the fuel compartments in the wing is avoided by using vertical stiffeners bonded to the ribs in addition to the spanwise stiffeners of the wing skin. Tests have shown that the strength of a Redux bonded joint is not affected by aircraft fuels and will remain pressure tight. In the aileron and flap structure aerodynamically clean surfaces have been produced using metal-to-metal bonding, which are extremely light and rigid.

Similar methods of construction are used in the manufacture of the fin and elevators, the rear pressure bulkhead for the fuselage, the fuselage floor and many other components.

Metal bonding has, in fact, been used very extensively throughout this excellent aircraft, the first pure jet aircraft to be used in regular service on the North Atlantic crossing. It is to the credit of the Comet's design that the advantages of this type of construction have been appreciated and exploited with complete success.

Fig. 5. Forms of tool used for bonding stringers to skin.

Reinforced Plastics Today

Brighton Conference Report

- Pre-impregnates
- Dough Moulding
- Flake Glass Reinforcements
- Spray Moulding

Over 400 delegates attended the reinforced plastics conference organised by the British Plastics Federation last month. This report highlights the major items discussed.

OVER 400 delegates, representing some 200 companies assembled at Brighton on October 22 for the opening of the three-day conference on reinforced plastics organized by the British Plastics Federation. The importance of this meeting was underlined by a press conference a few days before announcing the formation of a Reinforced Plastics Group within the structure of the Federation. This in effect is official recognition of the coming of age of the reinforced plastics section of the industry and the very existence of this Group may well contribute significantly to a more rapid expansion rate than has been the case hitherto.

The conference was chaired by Mr. H. V. Blake of Fibreglass Ltd., who is also chairman of the Reinforced Plastics Group. The conference comprised 24 major papers plus an important series of contributions from user industries. Preprints of the major papers, in book form, were available to delegates before the conference opened.

The outstanding points raised at Brighton may be summarized as follows:— (1) The need for the technical evaluation of reinforced materials, (2) the need for improved technology, (3) the need for truly fire resistant reinforced plastics, (4) the importance of pre-impregnated materials, (5) the importance of dough moulding materials. If only for this reason the Brighton Conference will stand as a landmark in the development of reinforced plastics generally and may also constitute the turning point of an industry with a difficult and unhappy past which should have an important future.

DR. J. J. P. STAUDINGER opened the conference and was followed by Professor C. Gurney who discussed his contribution on the strength of glass and glass fibres. In the course of this he mentioned the interesting phenomena noticed in glass rods of ¼ in. diameter where a standard sample might exhibit a breaking stress of 6,500 p.s.i. as compared with the same rod, acid etched and coated, which might exhibit a breaking stress of 250,000 p.s.i. It may be that further examination of this phenomena will show the way towards the manufacture of glasses of higher strength characteristics. His paper did not receive the discussion which it merited and only two direct questions were asked, one from Mr. A. W. Rawe of Microcell Ltd., who wanted to know if an etching and coating process would result in a permanent improvement in strength. Professor Gurney pointed out that his only experience of etching and coating was with rods and not fibres and thus he had no information to offer.

Flake Glass

Professor G. R. Rugger, of the Picatinny Arsenal, U.S.A., made a most important and interesting contribution on the development of flake glass laminates. The history of the work goes back some four years and has been under the supervision of the U.S. Army Ordnance Corp. The reasons for examining flake glass were first that such glass should have multi-directional properties as contrasted with the uni- or bi-directional properties of woven fibre laminates, secondly that the effective strength to weight ratio should be increased, thirdly that the ability of the flake to pack more closely would increase the bonding area, fourthly that flake laminates would, by hypothesis be stiffer, fifthly that flake as a raw material should be cheaper than fibre, and finally that the major difference between the theoretical strengths ascribed to glass and the actual values obtained from fibres suggested that there was scope for the examination of glass in alternative forms. With this brief, a great deal of investigational work has been carried out and although much remains to be done before these laminates can be considered for structural purposes, the basic thinking appears to offer much hope. The question of increasing the bond area and the elimination of voids by increased packing indicates that a material of better engineering properties should result; there may also be the possibility of a more standard product since if one is able to eliminate at least some of the variables, of which the actual quantity of glass per cubic inch is one, at least some practical progress will have been made. Mr. B. Parkyn put the question "What is the surface area of the flakes?" Professor Rugger answered by pointing out that generally speaking there was a ratio of 25:100 of thickness to area. He also pointed out in his paper that as with fibres, the strength characteristics increased as the thickness decreased. Mr. Rawe of Microcell Ltd. wanted to know about the stiffness of flake, and Professor Rugger said that tests so far show that flake laminates are more stiff than fibre laminates and that the cost at the moment is comparable to chopped strand mat. Price eventually should be half that of mat.

Fabric Construction

Mr. Haythornthwaite of Marglass Ltd., contributed a paper on the effect of fabric construction and properties on the physical properties of resin-glass laminates. He set out to examine the relation between laminate properties and various factors which affect fabric structure and in the course of this embraced plain weave fabrics, the effect of filament size, the balance of fabric construction, fabric thickness, finishes, and other significant aspects. Again, the discussion on this paper hardly did justice to the mass of information presented. It is clear, however, that the evaluations carried out by Marglass offer an important base-line from the fabric standpoint and as such should be widely disseminated.

Bristol Aircraft Ltd. have been in the front rank of companies investigating the properties of reinforced plastics for a long time, and Mr. A. W. Thompson's contribution entitled "Further Work on the Fatigue and Creep Properties of Laminates," highlighted four aspects of the company's work, (1) on general fatigue properties, (2) on the importance of a low testing speed, (3) on the method of curing materials for high fatigue strength, and (4) on creep properties.

The conclusions under item 3 are of vital interest. First it is clear that epoxides give better strength retention than polyesters. Secondly, that even in the case of epoxides, correct resin formulation is essential. One of the most hopeful indications was that properly made resin-glass laminates can show a strength retention in fatigue considerably higher than aluminium alloys, and in certain cases better than steel.

Another organization which has pioneered test evaluation is the R.A.E. at Farnborough, Dr. R. B. Heywood's paper discussed the present and potential fatigue strengths of resin-glass laminates and was divided into three parts, testing methods, materials research and design data.

He stressed the importance of designing new types of fatigue testing machines to meet the special requirements of reinforced plastics and the paper as a whole offered a valuable view of the present situation. The tabular data was particularly well presented.

Flexural Strength

Mr. K. J. Brookfield, Fibreglass Ltd., discussed his contribution, an important topic, the effect of heat and water immersion on the flexural strength of certain resin-glass laminates. He first of all referred to the extensive review of all of the existing data which had been made, which showed that all resin-glass laminates

Conference Programme

"PROPERTIES OF THE BASIC MATERIALS"

"Glass Fibres in Reinforced Plastics," by *Professor C. Gurney, University College, Cardiff.*

"Development of Flake Glass Laminate," by *Professor G. R. Rugger, Picattiny Arsenal, U.S.A.*

"The Effect of Fabric Construction and Properties on the Physical Properties of Glass Fabric/Resin Laminates," by *Mr. E. Haythornthwaite, Marglass, Ltd.*

"Fatigue and Creep Properties of Plastics Laminates," by *Mr. A. W. Thompson, Bristol Aircraft, Ltd.*

"Fatigue and Creep Properties," by *Dr. R. B. Heywood, R.A.E., Farnborough.*

"The Effect of Heat and Water Immersion on the Flexural Strength of Certain Glass Fibre/Polyester Resin Laminates," by *Mr. K. J. Brookfield, Fibreglass, Ltd.*

"The Flexural Strength and Electrical Properties of Silicone Glasscloth Laminates at Elevated Temperatures," by *Mr. J. H. Davis and Mr. P. A. Griffin, Midland Silicones, Ltd.*

"Electrical Properties of Glass Fibre Epoxide Resin Laminates," by *Mr. J. Carey and Dr. F. P. Hiron, Shell Chemical Co., Ltd.*

"Weathering of Reinforced Plastics Laminates," by *Mr. W. H. Moss, Formica, Ltd.*

"Structural Strength and High Temperature Properties of Asbestos Reinforced Plastics," by *Mr. D. V. Rosato, Raybestos-Manhatten, Inc., Pennsylvania, U.S.A.*

"Technical Requirements for Reinforced Plastics—an Overview 1958–1963, by *Mr. W. M. Keller, Owens-Corning Fiberglas Corporation, U.S.A.*

"APPLICATIONS"

"The Role of Peroxides in Curing Polyester Resins and Their Influence on the Physical Properties of Reinforced Plastics," by *Mr. J. W. Cywinski, Novadel, Ltd.*

"Glass Reinforced Plastics for Chemical Plant and Equipment," by *Mr. R. S. Ogg, A. E. Griffiths (Smethwick), Ltd.*

"The Construction and Long Term Performance of Polyester/Glass Fibre Sectional Tanks," by *Mr. A. W. Rawe, Microcell, Ltd.*

"Glass Reinforced Plastics for Translucent Building Panels," by *Mr. G. S. Galt, Galt/Glass Division, Durasteel, Ltd.*

"Glass Reinforced Plastics for Boat Hulls," by *Mr. W. J. Stevenson, Mechans, Ltd.*

"Glass Reinforced Plastics for Motor Car Bodies," by *Mr. R. F. Hill, Hill's Fibre-glass Developments, Ltd.*

"MANUFACTURE"

"Tooling with Epoxide Plastics," by *Mr. P. G. Pentz Leicester, Lovell & Co., Ltd.*

"Epoxides in Glasscloth Laminates in Tooling," by *Mr. P. A. Dunn, Ciba (A.R.L.), Ltd.*

"The Simultaneous Deposition of Fiberglas and Resin,"by, *Mr. D. F. Anderson, Rand Development Corp., Cleveland, U.S.A.*

"The Properties and Methods of Use of Pre-impregnated Reinforced Plastics," by *Mr. R. Kris and Mr. J. B. Cameron, Aeroplastics, Ltd.*

"The Manufacture, Properties and Applications of Dough Mouldings," by *Mr. J. D. Davies and Mr. K. A. Scott, British Resin Products, Ltd.*

"Medical Hazards of Dust and Vapour in the Plastics Industry," by *Dr. E. E. Lieber, Microcell, Ltd.*

"USER INTERESTS SESSION"

"Twelve Years of Polyester Resins," by *Mr. B. S. Parkyn and Mr. G. C. Hulbert, Scott Bader & Co., Ltd.*

Statements on their problems in the use of Reinforced Plastics by the following:—

British Transport Commission, *Mr. S. Bairstow.*
London Transport Executive, *Mr. R. I. D. Arthurton.*
BP Exploration Co., Ltd., *Dr. T. F. Gaskell.*
Shell Tankers Ltd., *Mr. K. Fleming.*
De Havilland Aircraft Co., Ltd., *Mr. J. K. Crowe.*
Vickers Armstrong (Aircraft) Ltd., *Mr. R. D. Edwards.*
English Electric Co., Ltd., Luton, *Mr. P. R. Green.*
Admiralty (DNC Bath), *Mr. J. W. Harrington.*
Naval Architect, *Mr. J. Birkerdike.*
Ministry of Supply (Mexe), *Mr. B. T. Boswell.*
Tersons, Ltd., *Mr. L. F. Bull.*
British Moulded Plastics Ltd., *Mr. N. Clark.*
Kestner Evaporator and Engineering Co., Ltd., *Mr. I. Burridge.*

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loose strength with rise of temperature and in the presence of water. He then reviewed the extensive test programme initiated by Fibreglass Ltd., which has attempted to define the precise losses to be expected in this sector.

Silicones

Mr. J. H. Davis and Mr. P. A. Griffin of Midland Silicones Ltd., reported on the flexural strength and electrical properties of silicone glass cloth laminates. The principal applications of these laminates have been in the electrical field although some mechanical applications have been found. The general conclusions show clearly that the outstanding resistance of silicone laminates at temperatures in the region of 275° C. in terms of strength will ensure an important market for these materials. The tabular matter presented with this paper was of a very high order.

Dr. F. P. Hiron and Mr. J. Carey discussed their contribution on the assessment of the electrical characteristics of epoxide resin-glass laminates. A sample test procedure was described and it is hoped to extend these tests to correlate the electrical and mechanical properties of such laminates. The paper included discussions on insulation resistance as the key to the assessment of the materials and one of the interesting results was the obvious influence of the curing agent used on electrical behaviour. Again, the paper was extremely well documented.

Weathering Tests

Mr. W. H. Moss of Formica Ltd., then discussed the weathering of reinforced plastics, and provoked a stimulating discussion. In the course of his address he described the accelerated weathering test system with which he has been associated. Professor Rugger wanted to know if these tests had been applied to plastics materials other than laminates. Mr. Moss confirmed that they had and said that he had complete faith in these tests as a means of forecasting long term weathering properties. Mr. G. N. S. Farrand of the Admiralty, asked what the effect would be, in the U.V. phase of these tests, with laminates containing U.V. absorbers. Mr. Moss suggested that since, in his opinion, U.V. absorbers did not remain in the laminate for very long, they had probably little influence on the test.

Mr. A. Baker of Bristol's presented a contribution by Mr. D. V. Rosato on structural and heat resistant asbestos reinforced plastics. This contribution was admirably illustrated with photographs of typical applications, particularly those in the Vanguard rocket. This paper will well repay reading in full in view of the excellent characteristics, particularly in the high temperature field, which these laminates exhibit.

Mr. W. M. Keller of Owens-Corning Fiberglas Corporation, discussed the technical requirement of reinforced plastics for the next five years.

Peroxides

Mr. J. W. Cywinski of Novadel Ltd., reported in great detail on the role of peroxides in curing polyester resins and their influence on the physical properties of reinforced plastics. This contribution was excellently documented and will undoubtedly provide a base-line for all further work in this direction. Mr. Cywinski's conclusion was particularly relevant when he said that the curing of polyester resins is a much more complicated matter than may occur to the fabricator and that much remains to be done before we can be sure that we have adequately controlled the polymerization stage so that the best required properties in the laminate are obtained.

Chemical Plant

Mr. R. S. Ogg of A. E. Griffiths (Smethwick) Ltd., discussed the usage of resin-glass plastics in chemical plant and pointed to the lack of

A tank made with Aeroplastics pre-impregnated materials.

detailed case histories and to the fact that from the point of view of chemical attack, the combination of resin and glass in a laminate is often weaker than the chemical resistance of the resin and glass separately. He also noted the high shrinkage factor of polyester resins during curing which gives rise to difficulties from the chemical point of view. He suggested that further attention should be given to the use of furane resins for the inner shells of tanks and other chemical plant. His paper provoked considerable discussion; Mr. Waxman, of Dexion Ltd., wanted to know if there was any lack of adhesion in these combination laminates of polyester and furane. Mr. Ogg said that provided that the second layer was applied to the convex side there should be no trouble. Mr. Cooper, of Fibreglass Ltd., wanted to know about the uses of Terylene and Dynel as reinforcements, and Mr. Ogg reported that they had been successful, Terylene having been used for etching baths for turbine blades, notwithstanding the relatively poor wetting properties of Terylene. Mr. Clay, of I.C.I. Fibres Division, also drew attention to the improved acid and abrasion resistance conferred by Terylene.

Mr. A. W. Rawe, of Microcell Ltd., delivered a paper on resin glass sectional tanks and in this paper provided an excellent example of a typical successful case history.

A similar type of paper was offered by Mr. G. S. Galt, of Durasteel Ltd., on translucent building panels, and he discussed in particular weather and fire resistance. In the former sector he pointed to the benefits of a good layer of resin on the external surfaces and also noted a drawback in the presently available fire retardent additives, which reduce weather resistance and cause discoloration.

Boats

Again, with a successful case history to describe, Mr. W. J. Stevenson, of Mechans Ltd., discussed the development of the resin-glass lifeboat. He unhesitatingly placed these laminates far ahead of timber, steel and aluminium, as materials of construction.

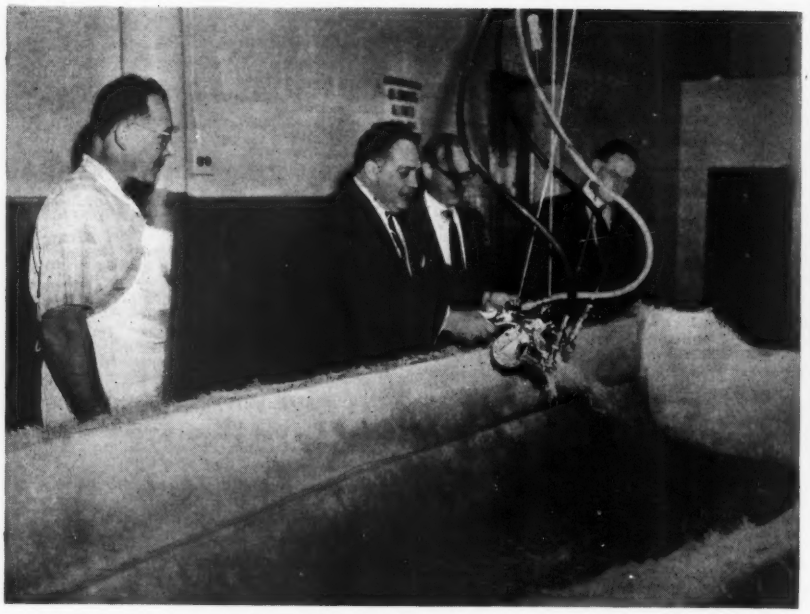
Mr. R. F. Hill, in the same vein, described resin-glass materials for motor car bodies and his conclusions make comforting reading. He said that too many have entered this field under the "anyone can do it" stimulus whereas the whole process constitutes a technology in its own right and requires a most careful study.

Mr. P. G. Pentz delivered a beautifully illustrated address on tooling with epoxide resins which created an interesting discussion, and he was questioned by Mr. Ogg, Mr. Oakes of de Havilland and Dr. Andres of Bayer. The last mentioned suggested that the volume shrinkage figures given by Mr. Pentz for polyesters were much too high and that much more favourable figures have been obtained in Germany.

Mr. P. A. Dunn and Mr. E. M. White, of Ciba (A.R.L.) Ltd., discussed their paper, epoxy resins and glasscloth laminates for tooling and again their views caused discussion.

Spray Technique

Mr. D. F. Anderson discussed the Rand process for simultaneous deposition of glass and resin and was questioned by several members of the audience. Dr. Jaray suggested that the process was suitable for non-stressed applications but was critical of its future in the technical sphere. Professor Rugger and Mr. Moss questioned the amount of glass fines discharged into the atmosphere and also the hazard of strong sytrene vapour concentration. Mr. Anderson suggested that with adequate extraction facilities these problems do not arise.



The Rand gun in use at the workshops of Courtaulds Plastics Developments Ltd., Canada.

Mr. R. Kris and Mr. J. B. Cameron presented their paper on pre-impregnating materials, described in the October issue of *Plastics*, pages 353 to 356. Mr. Kris was asked by Mr. Oakes if resin formulations have been evaluated for the various techniques in reinforced plastics, and Mr. Kris underlined the flexibility of the manufacturing process for pre-impregnates to meet customer requirements.

Dough Moulding Compounds

Mr. J. D. Davies and Mr. K. A. Scott reported on the manufacture, properties and applications of dough moulding compounds. This paper put both the advantages and disadvantages into clear relief and was admirably presented. It is clear that this fundamental work by British Resin Products marks the starting point for a much wider investigational programme by the reinforced plastics industry as a whole.

Dr. E. E. Lieber, medical officer of the Microcell Group of Companies, discussed the medical hazards of dust and vapour in the industry and stressed the importance of the industrial medical officer as a part of the management team if the benefits of medical supervision are to be fully realized.

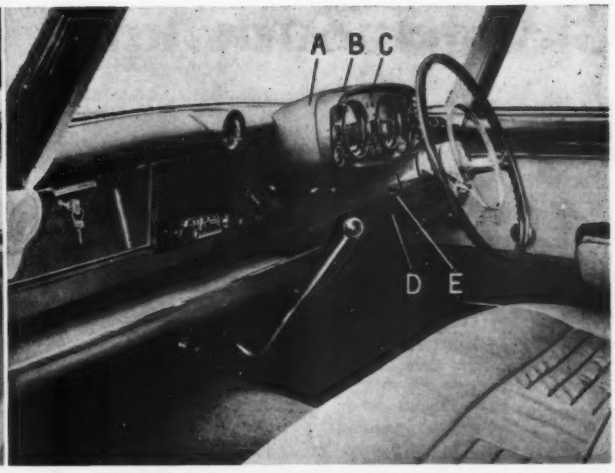
Mr. B. S. Parkyn and Mr. G. C. Hulbert, of Scott Bader, made a most interesting contribution entitled "Twelve Years of Reinforced Plastics." They noted the steady fall since 1946 in the cost of glass reinforcements and resins and the encouraging growth curve shown in the consumption of resin-glass materials. They stressed the necessity for a fireproof resin and also the absolute necessity of being able to supply to the customer a material which is ready to mould; they concluded: "When all firms engaged in moulding reinforced plastics can remain engineers and moulders and do not also have to be resin chemists, then indeed the reinforced plastics have come of age."

The final phase of the conference was the User Interests session which, whilst it was extremely interesting, indicated clearly the wide gulf between what reinforced plastics are and what they can do, and what the users want them to do. Here was clear indication of the importance of the technical salesmen, technical publicity and technical advertising; potential users are interested in reinforced plastics but they remain largely unaware of the technical considerations.

In reviewing the comments made, particularly helpful contributions were made by Mr. Bairstow, who reported on reinforced plastics for use by railways, Dr. T. F. Gaskell who was hopeful of the use of resin-glass pipes, Mr. K. Fleming, who saw considerable useage for these materials in ships, particularly tankers, and Mr. R. D. Edwards, who was interested in aircraft applications. He gave some interesting figures; in the first Vickers Viscount there were 88 polyester-glass components, in the latest Viscount there are, 715 applications, and in the Vanguard there will be 1,400.

Other speakers set rather more critical standards, and these, of course, were welcome for their effect is to raise the industry's standards as a whole.

The conference concluded with a short address by the chairman, Mr. H. V. Blake, who offered an estimate of 100,000 tons of reinforced plastics materials being used this year in the Western world of which 80,000 tons would be in America. Mr. Blake and the officers of the British Plastics Federation may take pride in this very successful conference and readers of this report may like to know that the conference papers, in bound form, may be purchased from the Federation at 47–48 Piccadilly, London, W.1.



The Rover 3 Litre

THIS issue of the journal underlines the current attention focused on plastics and transportation. The preceding pages describe the Comet 4; here we are concerned with a notable contribution to the automobile industry, in the restyling of the fascia panel of the new Rover 3-litre car, seen at the Motor Show a fortnight ago for the first time.

Look first at the two photographs above. On the left is an example of the normal range, in this case the 105 saloon, solid and dependable. On the right is the new version for the 3-litre, the same essential layout but vastly sleeker and thoroughly in keeping with the dignity of one of Britain's leading cars. The instruments have been re-housed in an elegantly designed body, and the steering column enclosed by a streamlined shroud that houses the overdrive control, and automatic control where fitted.

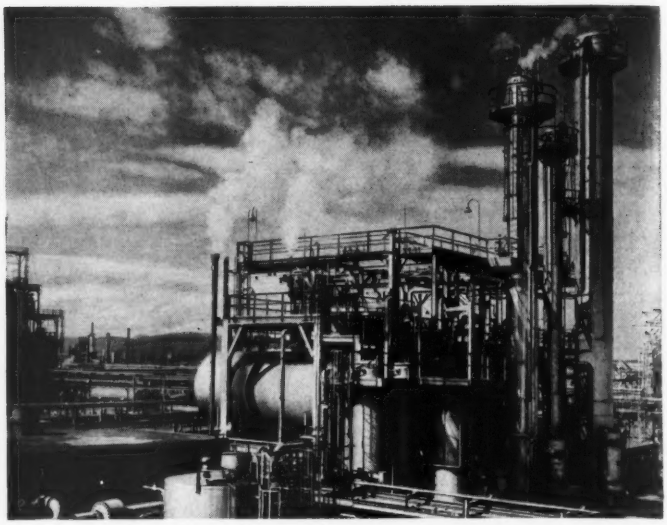
Ekco Plastics Ltd., and The Rover Company, Ltd., joined forces on this project nearly a year ago. The Rover requirements were simply put; quality, impeccable appearance, and a "Rover" finish. There were several major problems, including the requirement that mouldings would be needed for left- and right-hand drive, with attendant provision for manual gear change, overdrive, and automatic drive. By ingenious tool design, the entire requirement has been met by the use of a combination of some nine tools at a time out of a total of 15. The tools were made by Ekco, at a cost of over £20,000.

Specimen mouldings can be seen in the panel on the right, keyed with the photograph at right above. All but two items are compression moulded in black phenolic powders. Press capacities involved range from 10 to 600 tons, mainly employing one or two impression tools. These mouldings include the steering column shroud (D), fitted plates (E), instrument body housing (A), instrument panel face (B), and light bulb holder. Two of the items are injection moulded, the gear change indication plate and the facing panel (C) fitted into the instrument body unit. Diakon is used for both mouldings. The former item is interesting by virtue of the "piped light" properties of Diakon. Except for a small area at the bottom of the plate and the lettering, the entire moulding is sprayed black. A small light bulb is located at the bottom, and at night the letters on the plate glow with a diffused light, making identification simple. In the case of the Diakon panel, the smaller holes are punched during the moulding process, thus eliminating any knit lines. All the mouldings, compression and injection, are placed on cooling jigs on removal from the tools.

The photographs on this page of the mouldings, taken at the Southend works of Ekco Plastics Ltd., illustrate well the contribution that plastics have made to the Rover styling.

Grangemouth Revisited

New plant constructions will raise investment programme at Grangemouth to over £30m. A major source of materials for the British plastics industry.



Fractionating columns, No. 1 ethanol plant, with part of No. 1 ethylene fractionators in the background.

GRANGEMOUTH has been the site of an oil refinery for some 35 years. Today, the oil refinery continues, on a larger and more diverse scale, but in addition there is now a very large petrochemicals complex in operation, manufacturing the raw materials and intermediates for plastics, synthetic rubbers, paints, pharmaceuticals, detergents, dyestuffs, and other items.

British Hydrocarbon Chemicals Ltd., formerly British Petroleum Chemicals Ltd., was formed in 1947, and is jointly owned by The British Petroleum Co., Ltd., and The Distillers Co., Ltd. Two subsidiaries of B.H.C. operate at Grangemouth, Forth Chemicals Ltd., in which Monsanto Chemicals also have an interest, and Grange Chemicals Ltd., in which the Oronite Chemical Co. of the U.S.A. participate.

The B.H.C. plant is one of the "big four" units in this country in the petroleum cracking field, the others being I.C.I., Shell, and Esso.

Centre for Plastics Materials

For the plastics industry, the B.H.C. plant has special significance; Grangemouth already produces butadiene for synthetic rubbers and ethylene which, when reacted with benzene produces ethyl benzene from whence, by dehydrogenation, styrene monomer is made. Next year will see the completion of the plant for the manufacture of cumene, and hence phenol, for thermosetting resins, and the polythene plant for the production of the material to be marketed by British Resin Products Ltd., under the trade name Rigidex Polyethylene.

An important phase in the Grangemouth project was reached on October 17 last when the first pile was driven for a third ethylene plant. This is scheduled for completion by mid-1960 and when on stream it will ensure a full supply of ethylene for the low pressure polymerization plant under construction, as noted above, which will operate under a Phillips licence. The No. 3 plant will be rated at 70,000 tons a year, and as such will be the biggest single ethylene plant outside the U.S.A. Its cost will be £6,000,000. The total investment programme when the third ethylene plant and certain other projects now in hand are completed, will exceed £30,000,000.

Driving the first pile. In the centre foreground, from left to right, are Mr. C. E. Evans, General Manager, B.H.C., the Rt. Hon. John Maclay, and Mr. J. M. Pattinson, Chairman of B.H.C.

The latest expansion, the No. 3 ethylene plant, was inaugurated, fittingly, by the Rt. Hon. John Maclay, Secretary of State for Scotland, before a distinguished audience, including Lord Polwarth, chairman of the Scottish Council for Development and Industry, and many leaders of industry. He was introduced by Mr. J. M. Pattinson, chairman of British Hydrocarbon Chemicals Ltd. Both stressed the important part that the Grangemouth project is playing, both in the petrochemicals sphere and as a major unit in the industrial development of Scotland. Mr. Pattinson also pointed out, significantly, that with the third ethylene plant having the effect of doubling the company's olefines manufacturing capacity, there may be the possibility of a further programme of investment.

Feedstock Consumption

Some idea of the dimensions of the project may be gained from the fact that a greater tonnage of oil is now going into chemical manufacture at Grangemouth than the total quantity of crude oil processed for fuel before the war. At that time the refinery handled 250,000 tons of oil a year. The input of feedstock to the existing B.H.C. ethylene plants is upwards of 400,000 tons a year, and when the new expansion is complete, it will be 800,000 tons.

Details of the styrene monomer plant at Grangemouth, operated by Forth Chemicals Ltd., were published in a special article in the December issue of *Plastics*, 1956.

World's Industry Employs Plastics

A monthly survey of technical articles published in journals throughout the world.

The original articles from which these abstracts are taken can be seen at the Patent Office Library, 25 Southampton Buildings, Chancery Lane, London, W.C.2. Photostat copies can be obtained from the same source, price 1/6 per page (postage extra). It should be noted that the page number given below the abstract is that of the page on which the article commences.

MATERIALS

Plastics in Italy

A DISCUSSION on the production, sales and development of plastics in Italy. Particular attention is paid to the present and future significance of polypropylene products and it is noted that though there is as yet no manufacture of foamed urea resins or of epoxide resins in the country, research is being carried out on these products. Output figures are given for various resins and special reference is made to isotactic polystyrene which has a melting point of 230° C.; methods of working this difficult material are being investigated. Research on the use of mixed polymers of ethylene and propylene for road-vehicle tyres is also commented on.

(*Kunststoff-Rundschau*, 1958/July/316.)

Achema 1958

ILLUSTRATED stand-by-stand review, classified, with each group further subdivided under manufacturers' names. About 75 exhibitors are listed in all.

(*Kunststoff-Rundschau*, 1958/August/349.)

"Siliplast" for Foundry Cores

DR. KALPERS describes the advantages "Siliplast" core binder (manufactured by F. Raschig G.m b.H., Ludwigshafen, Rhein) for metal foundries. It is claimed to give cores of accurate dimensions, to yield an easily worked sand, to cut drying time, to be odourless and giving rise to little gassing. Green strength is high and at 220° C., drying time may be halved as compared with oil-sand cores. The qualities of a suitable core sand for use with the binder are set out, and to such sand, about 2% to 3% by weight of "Siliplast" is added. Cores may be produced by any of the usual processes and give sharp impressions, but if specially highly finished cores are required, they should be sprayed over before drying with Resinol synthetic resin with 5% water added; alternatively, the core backing may contain 0.5–1.0% Resinol, but should be free of sulphite if this be the case. If the cores are to be stored for longer than usual, they should be covered with wet sacking or plastic foil.

(*Der Plastverarbeiter*, 1958/May/185.)

Low Pressure Polythene Production

AS from 1959, there will be produced monthly at the Chemische Werke Hüls A.G., Marl, Kreis Recklinghausen, 500 metric tons of "Vestolen" low pressure polythene. Various types of this plastic will be produced and the plant will be capable of modification to increase its capacity to any desired extent at shortest notice.

(*Der Plastverarbeiter*, 1958/May/190.)

Astralon in Cartography

AN account by Walter and Becke of the special grade of vinyl copolymer "Astralon" used for cartographic work. This grade is transparent, of high dimensional stability, has a very even surface, may readily be drawn on or engraved and may be coated with light-sensitive compounds for photographic purposes. The authors give comparative curves for alteration in length under different conditions of atmospheric humidity for "Astralon" and two other plastics, and a curve for light transmission at various wave lengths. A table of mechanical properties is presented and considerable detail is given regarding the treatment of "Astralon" with light-sensitive emulsions for photo-copying processes. The use of the material for multi-colour printing and for deep drawing for relief maps is also dealt with.

(*Kunststoffe*, 1958/March/141.)

World Plastics Economy

PRODUCTION, export, import, and consumption figures for plastics for 1957 in U.S.A., West Germany, Great Britain, Japan and Italy. Amongst the data given are consumption figures *per capita;* these range from 10.7 kg. in U.S.A. to 2.3 kg. in Italy.

(*Kunststoffe*, 1958/April/145.)

Working and Application of Acrylic Resins

WEISERT summarizes briefly the various forming processes applicable to the acrylics, including injection moulding, extrusion, moulding by pressing, warm forming, assembly with adhesives, welding and machining; in connection with cutting apparatus, he refers to the use of oils or emulsions as coolants/lubricants. Mechanical properties are set out in tabular form and curves are given for mechanical properties in relationship to temperature. The section dealing with applications illustrates many architectural uses in connection with illuminating systems, together with a wide variety of mechanical applications and specialized uses.

(*Kunststoffe*, 1958/April/147.)

TECHNOLOGY

Plasticizing the High Polymers

FIRST instalment of a paper read by Passedouet in November, 1957, at the Centre de Perfectionnement Technique, 28 Rue St. Dominique, Paris. The author examines the physics and mathematics of the plasticizing process in relationship to a number of high polymers and with regard to a large number of industrial plasticizing agents.

(*Industrie des Plastiques Moderne*, 1958/February/49.)

Suspension Polymerization of Styrene

IN an investigation into the suspension polymerization process it was found that a series of initiators used in mass polymerization are not nearly so effective in suspension polymerization. It is shown that an addition of emulsion of block polystyrene to the monomer accelerates the suspension process and gives an increase in molecular weight. A block suspension method is suggested which reduces the polymerization time and increases the molecular weight of the polymer. Properties of the polystyrene obtained by the suspension and block suspension methods are not inferior to block polystyrene and even exceed those of emulsion polystyrene.

(*Khim. Prom.*, 1957/August/1.)

Production of Isoprene Rubber

THE authors of this article, N. P. Fedoranko and G. F. Borisovich, give some of the properties of a synthetic rubber produced by the catalytic polymerization of isoprene. A comparison of these properties with those of natural rubber is made and the result of a test in which this rubber has been used for tyres is given. In this latter case, after six months' use the tyres proved to have similar operating indices to those of natural rubber. The authors then go on to discuss the three most important methods for the production of isoprene in the U.S.S.R. The most favourable method being the dehydration of isopentane or isopentene. The isopentane can be obtained by direct distillation from the benzenes obtained from the various refineries The second method for the syntheses of isoprene is by the use of acetone and acetylene. The third method discussed is the syntheses from formaldehyde and isobutylene which is carried out in two stages.

(*Khim. Prom.*, 1957/August/10.)

Finishing Plastic Spectacle Frames

CONCLUDING sections of a continued account, dealing chiefly with methods of polishing Tumbling with various media is exhaustively dealt with, special emphasis being laid on the difficulties which may arise as a result of the plastic smearing on the grinding or polishing agent, and of the latter "balling up." The use of wood shavings soaked in paraffin (or of cherry stones and the like) is noted, but the employment of such media results in slow working and necessitates a large number of tumbling drums.

(*Der Plastverarbeiter*, 1958/May/177; August/297.)

Surface Finishing of Plastic Sheet

A DISCURSIVE account by Dornbusch on the meaning of the expression "composition of design" in relationship to printed and embossed designs. On the basis of his critical approach to existing methods for finishing plastic sheet, the author attempts to equate more closely the economies of production and the satisfaction of æsthetic requirements, as well as to develop new methods of surface treating sheet.

(*Kunststoffe*, 1958/March/106.)

LETTERS TO THE EDITOR

Correspondents are reminded that a stamped addressed envelope should be enclosed in all cases where a personal answer is desired. It is understood that any letter received may be published at the discretion of the Editor.

EDUCATION AND THE PLASTICS INDUSTRY

SIR,—I should like to comment on certain points raised in your Editorial "Education in Plastics" in the October issue of your journal.

I think there is no doubt that as far as the raw materials side of the industry is concerned, the type of course leading to the Diploma and Associateship of the Plastics Institute can be a valuable part of the training of young men aiming to be technicians and technologists. In the Plastics Division of I.C.I., for example, we have some 30 young men attending various stages of these courses.

In the plastics materials manufacturing industry which is concerned with chemical and physical research and development in the field of polymers, the chemical manufacture of a wide range of plastic materials, and the design and operation of many types of manufacturing plant and equipment, there is need for a great variety of scientists and technologists, only a proportion of whom will be plastics technologists in the narrower sense which is implied in your Editorial. Much of the work in this side of the industry is carried out on a team basis by groups of technologists, each a specialist in a particular sphere, rather than by individuals who have had training and experience over a wider field of plastics technology.

Nevertheless, there is a need also, as indicated above, for people in this side of the industry who are expert in the more specialized field of what is termed plastics technology. The young trainee working in this field is well assisted by courses of the type leading to D.P.I. and A.P.I. The larger number, however, of the opportunities for young men trained through these courses must be in the fabricating side of the industry, and it is indeed unfortunate if this form of training is being overlooked by the fabricating companies.

Whatever the faults may be on the part of industry, one questions whether the Ministry of Education has in fact come more than half way in dealing with the problem on a national basis. Probably nothing would help these courses more than the provision by the Ministry, and as a result of their stimulus also by the Local Education Authorities, of adequate grants, free from unnecessary means tests, to enable young people leaving school to undertake this type of training on a full-time basis.

DR. J. C. SWALLOW.
Chairman, Plastics Division,
Imperial Chemical Industries Ltd.,
Welwyn Garden City,
Herts.

SIR,—In your Editorial in the October issue you put the plastics industry in the category of those who are woefully limited in their approach" to the problem of technical education. It is hardly fair to condemn the whole plastics industry, as many firms in it appreciate the vital necessity of adequate technical training and are generous and willing subscribers to the Plastics Industry Education Fund. On the other hand one cannot but admit that considering the importance and growth of the industry—an industry which, quite as much as any other, needs personnel with technical qualifications—the support given to the fund does not come up to what one would expect.

The sandwich courses to which you refer are an excellent means of providing the right type of training: six months in a factory, sandwiched with six months of college study over a four-year period.

These sandwich courses come under two headings: (1) industry based and (2) college based.

In the former, firms train their staff on their own factories and arrange for the college training, the whole course fitting the individuals for progressive posts within the firm.

In the latter case students enter technical colleges who arrange with firms for the six month periods of industrial training. The helpful co-operation of firms is fundamental and it is desirable that it should be extended to enable the student to widen his experience by spending the industrial periods of his training on different factories.

It is the college based student that the Plastics Industry Education Fund is out to help and encourage.

In expressing appreciation of the emphasis you put on technical training. I sincerely trust that it will encourage a larger entry of students to the enterprising technical colleges which have arranged sandwich courses in plastics.

Your words should stir industry to a full realization of what lies ahead and what it will have to face in the future; it will only be with a sufficiency of trained technologists that the future can be faced with confidence. As a nation we have the reputation of being slow starters. The race with other countries is on, and if that is fully realized there is no reason why we should not, as we always do eventually, gain our rightful place in the lead.

I cannot close without appealing to those firms in the plastics industry who are not already subscribers to the Education Fund to support it by donation or preferably by covenant. A report on the work of the trustees of the fund was widely circulated during the early part of the year. A copy of the report will be gladly sent to anyone requiring it.

CYRIL S. DINGLEY.
Chairman of Trustees,
Plastics Industry Education Fund,
The Plastics Institute,
6 Mandeville Place,
London, W.1.

SIR,—Education has been one of the major preoccupations of the country in the last few years, and in one sense this is a healthy manifestation. In another way, however, the continued discussion is somewhat depressing since it reflects our inability to meet the challenge. Your Editorial comments in October underlined this less encouraging aspect of the situation, at least insofar as it concerns the plastics industry.

Clearly much remains to be done if the trained personnel, necessary for the continued advance of the industry, is to be forthcoming. Its growing complexity makes it more and more obvious that specially trained people are essential, and the idea that a chemical or engineering graduate can be readily "licked into shape," or that, at a lower level, a worker can pick it up as he goes along, is no longer adequate.

From my experience as a teacher I would proffer two suggestions. The first is fundamental. It would be a good thing if industry could work out some basic conceptions of what it requires from its trained staff. The problem of education to meet these requirements would then be more clearly defined and thus capable of solution. Such a clarification of the needs of industry is not an easy task, not least because of the great diversity as between its different branches, but it is no less necessary for that.

My second point refers to what I believe is the quickest conversion of raw graduates, or their equivalent, into people who have some fair idea of what the plastics industry is about. I think it would provide a profitable investment to companies, individually or jointly, to send selected graduates or people who have worked in industry and simultaneously obtained their Higher National Certificates, for a full-time one-year course that leads to the Associateship of the Plastics Institute. In this one year they would obtain an overall picture of materials and machines in use, and also some theoretical background in the chemical, physical or engineering aspects of the business.

We have some such students at this

College, although all too few; in my view, this is probably the most economical way of producing plastics technologists of high calibre.

M. KAUFMAN.

Senior Lecturer, Plastics Technology,
National College of Rubber Technology,
London, N.7.

SIR,—Your Editorial on the current position of education in plastics is of great interest. The potentialities of the Diploma in Technology courses which are held in Colleges of Advanced Technology or in regional colleges are not yet fully realized.

The sandwich course at this College has been devised to give a sound training in advanced chemistry, together with a choice of study in the applied chemistry and technology of plastics in line with modern requirements.

It is noteworthy, however, that 15 out of the 32 in the present three years of the Course have elected to study in the plastics field, but of the 15 only three have been sent to us directly by the industry for the purpose of such training; a further three obtained leave of absence to become College based students, whilst the remaining nine came directly from school, themselves electing to specialise in this field. Apart from the lack of industry based students for the Diploma in Technology courses, more support is needed for part-time day release training in the plastics field.

In this region there are many important utilizers of plastics materials with large and well-equipped plastics sections who value part-time courses for their employees, but there is still a need for more organized training at an Advanced standard for scientific and technical staffs.

Over a period of years we have established advanced part-time courses suitable for the Associateship of the Plastics Institute in the chemistry and technology of plastics, but too large a proportion of the students come to us as individuals studying in their own time.

The chemical industry, which has always supported part-time day release training, is also having some difficulty in supporting sandwich courses for the Diploma. The apparent obstacle being the release of young assistants from works or laboratories for periods of six months at a time, but there is heartening evidence that this great industry, in co-operation with the Technical Colleges, is trying to overcome the difficulties and is realizing the potentialities of this modern method of training.

I am of the opinion that if we as a country are to maintain our premier position in the industrial world in the next decade, then it will be more than ever necessary for the various industries—including the plastics industry—to reconsider the whole policy of technical and scientific training, and particularly to give support to these new types of higher technological courses on which so much depends.

J. H. SKELLON.

Chemistry Department,
Brunel College of Technology,
Acton, W.3.

SIR,—I was most interested to read your Editorial this month entitled "Education in Plastics."

It would be out of place for me as Secretary to the Trustees of the Plastics Industry Education Fund to comment on the response which firms in our industry have made to the opportunities which now exist for giving technical training to men who have taken up plastics as a career. I do know, however, that some Technical Colleges have been disappointed at the small number of applicants for the sandwich courses in Plastics Technology.

Some firms may perhaps take the view that if they release a young man for four years for a sandwich course they will lose his services not only for that period but permanently and for that reason they may not encourage this form of technical education. Nevertheless, the plastics industry as a whole must gain from having in it more young men with the Dip.(Tech.).

If his employers do not offer to release him, no young man in the industry should feel that he cannot take up a sandwich course for want of financial support. The Plastics Industry Education Fund is not assisting those young men who are sent by their firms on sandwich courses, but it is striving to help others who are "college-based." Twelve scholarships have already been awarded for this purpose and the Trustees have this year offered six new scholarships at the Borough Polytechnic, London, five at the Birmingham College of Technology and two at the Brunel College of Technology. These are, of course, in addition to the training grants for University studies and other scholarships at the National College of Rubber Technology.

S. P. THOMPSON.

Secretary to the Trustees,
The Plastics Industry Education Fund.

(*Editor's Note.*—Several other letters have been received on this topic, including contributions by Mr. H. V. Potter, chairman, Bakelite Ltd., and Dr. F. Aylward, Borough Polytechnic. These will be published in the December issue.)

Polythene Housewares

SIR,—Having read in the August issue of *Plastics* the article entitled "Polythene Household Ware," by Mr. G. J. Gilbert, we wish to make the following comments.

We feel that this article, as it stands, gives only a limited part of the polythene picture, such that it makes us very sceptical of the reaction of a non-technical buyer who, having read the article, wished to purchase polythene household articles.

Table 3 is an evaluation of various Alkathenes moulded under the same conditions, and shows the superiority of the Q.53 Grade. This superiority has been determined by boiling in a water/detergent/fat environment. Test results carried out in our laboratory have given the exact reverse and have shown that Grade 2 is superior to Grade 20, and that Grade 20 is superior to Q.53. The only difference in the tests carried out by us was that we put test dishes under an external stress, also that each grade of material 2, 20 and Q.53 was moulded under the optimum conditions applicable to each grade, not the conditions applicable to one particular grade, i.e. Q.53. This latter condition it appears did not occur in the author's experiments and could affect the results.

We feel that the combination of an active environment and an external stress is more representative of accelerated service conditions for correctly moulded articles.

Further, reading from Table 2 and 3, it would be quite reasonable to assume that mouldings in Grade 20 and Grade 2 Alkathene material are unsuitable for use in housewares. This we, and many of our competitors, know is not so. Grade 20 is, in fact, eminently suitable for polythene housewares as has been shown by our sales/returned faulty ratio. This fact has been borne out by the negligible number of returns we have had for the faults mentioned in the article.

Finally, on page 288 of the same issue of *Plastics*, there is shown Table 1, "Behaviour of Key Properties," in which it is stated that an increase in molecular weight distribution causes a decrease in resistance to stress cracking for comparable melt indices. Grade 20 Alkathene has a narrow range molecular weight distribution, Q.53 has a wide range molecular weight distribution, therefore, one can assume that the Q.53 is less resistant to stress cracking than Grade 20.

Here we have the ambiguous situation where two manufacturers of similar plastic compounds disagree on fundamentals.

As we appear to be at variance with the author on this subject we would be glad to learn whether any other moulder can confirm our findings in practice.

J. S. WALKER.

Joint Managing Director,
Fraser & Glass Ltd., London, N.12.

Leipzig Fair

SIR,—In Mr. M. Kaufman's interesting article on "Plastics in East Germany," published in the September issue of *Plastics*, he deplores the fact that, apart from R. H. Windsor Ltd., no plastics companies were represented at Leipzig Fair.

Mr. Kaufman's statement is inaccurate since the Plastics Division of I.C.I. exhibited at the 1958 Leipzig Fair and has arranged to appear again in 1959.

P. I. SMITH.

Manager, Publicity Department,
I.C.I. Plastics Division,
Welwyn Garden City, Herts.

New Productions

Plastic Film in Concrete Raft Construction

One of the main difficulties in concrete raft construction is the presence of crack-causing stresses set up by sub-grade or base restraint of inherent or induced movement in the raft. Various ways of reducing this friction between slab and base by providing some form of lubricant have been tried. British Cellophane Ltd. have recently introduced a multi-ply thermoplastic material 0.003 in. thick which they call Lubrithene. It is reported that when this material is interposed between the raft and the base the coefficient of friction between them is reduced to less than 0.25. This compares with the coefficient of 0.75 when polythene film is used and up to 1.5 when paper is used. The use of this material enables a saving in the materials and steel reinforcement when it is used. The main application of Lubrithene is in the construction of aircraft runways, roads and similar long expanses of concrete.

New Deck Covering

A new deck covering for exposed weather-decks has been developed by Semtex, the Dunlop subsidiary. Known as Gripdec and only $\frac{1}{16}$ in. thick, it represents an important advance over a purely anti-corrosive skin covering, and at the same time is neither as vulnerable to damage nor as expensive as heavier types of composition.

Gripdec, a product of high polymer technology, is a balanced blend of chemical rubber based on neoprene latex and resinous compounds containing a hard non-slip mineral filler. It has a tenacious bond to steel, but retains sufficient flexibility to withstand movement and deck tremors without becoming detached. It is also hard enough to remain unaffected by rough treatment. Other advantages are that it is immune to the effects of solvents, grease and oil; its dimensional stability does not deteriorate as a result of rapid changes of temperature; and there is no tendency towards brittleness or oxidizing in service.

Enquiries should be addressed to Semtex Ltd. (Marine Division), Semtex House, London, N.W.9.

Breathable Vinyl Coated Fabric

Arlington Plastics Development Ltd., Eastern Industrial Estate, Harlow, Essex, have produced a new addition to their Texturide range of vinyl coated upholstery fabrics that is permeable to air and moisture repellent. This will be known under the registered trade name of Textair.

It is made by a process new to this country and is unique among breathable vinyl coated fabrics in that the vinyl spread is not directional, which helps to ensure evenly balanced tear strength. This quality, combined with a specially designed backing cloth of great tensile and bursting strength, ensures unrivalled advantages of performance for all types of upholstery.

Melamine Faced Particle Board

Bartrev Board Co., Ltd., 3 Vere Street, London, W.1, who recently announced the introduction of Avtrev to the market, now announce an addition to the varieties in which their Melamine-faced particle board is available. Avtrev is now manufactured with a decorative Melamine face applied to both surfaces. Previously, Avtrev was introduced with one decorative Melamine surface and with one plastic or wood veneer balancer surface, in three qualities, varying in accordance with the thickness of the Melamine and with the type of balancer.

The manufacturers state that Avtrev can now be supplied with opposite surfaces finished in any combination of the patterns and colours in the standard range, thus providing architects and furniture designers with an extremely varied choice.

Switch Body and Cover

The mouldings illustrated left are manufactured by Birkbys Ltd in their ELO phenolic material for H. & E. Lintott Ltd. They are the switch body and cover assembly isolating safety switch.

This assembly is located in the back of electronic chassis and cabinets produced for Admiralty Guided Weapons and for general industry in connection with isolation "make and break" involving up to 5,000 volts.

Vinyl Tubing and Sleeving

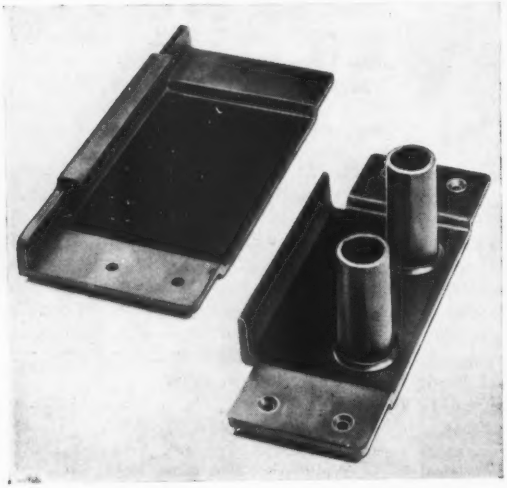
The Plastics Division of The Telegraph Construction & Maintenance Co., Ltd., of Farnborough, Kent, is now producing flexible and rigid p.v.c. tubing and sleeving. This bears the trade name Telcovin.

Telcovin flexible tubing is being made in black and white, in colours, or in crystal-clear transparent form. An important point is that Telcon offer it in two varieties, a standard type and a type made from a p.v.c. compound which has been passed by authoritative bodies as suitable for use in contact with consumable liquids, such as drinking water, milk, beer, etc. This latter type is in fact specially recommended for the pumping of beer from cellar to bar-counter, and for this application it is made in two standard sizes for fitting to pumps, viz. $\frac{1}{2}$ in. bore and $\frac{3}{8}$ in. bore, both having a wall thickness of $\frac{1}{8}$ in.

With the exception of the two special sizes mentioned above, the Company does not intend at present to manufacture p.v.c. tubing in a fixed range of diameters and wall-thicknesses rather will the policy be to produce to customers' specific needs, with an upper limit of $\frac{3}{4}$ in. bore.

Potato Peeler

Recently introduced into this country from Germany by Monsyd Kitchenware Ltd. is the water-operated Duchess Potato Peeler. This is now being manufactured in this country by Barclay-Stuart (Plastics) Ltd., of Brunswick Street, Luton, Beds., and consists of a number of mouldings in polystyrene and polythene. The peeler operates by rotating the base of the container which throws the contents against the sides which are, with the base, coated with an abrasive material. The base, which is mounted on ball-bearings, is driven by directing a jet of water against moulded cups which surround it in a similar manner to a turbine. The whole machine is supported on three legs fitted with rubber suction cups and the transparent lid is held down by polythene clips. The complexity and size of the mouldings can be seen in the accompanying illustration and we are given to understand that the complete tooling time for this was only 14 weeks.



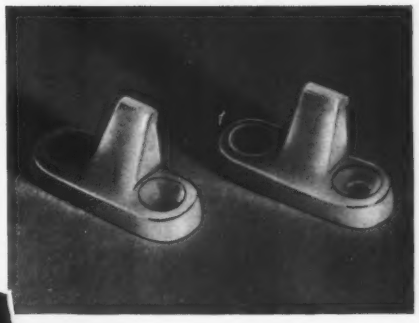
(Left) Switch body and cover moulded by Birkbys Ltd.

(Right) Plastics are used extensively in this potato peeler.

(Above) A.B.C. Television Weather Girl, Colette Wilde wears a pair of the new p.v.c. over-boots manufactured by Dunlop Rubber Co., Ltd.

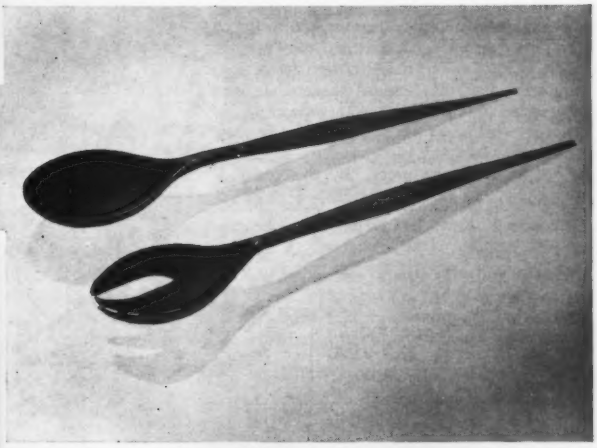
(Below) The Lestea pot marketed by Modern Home Products Ltd., 510a Coventry Road, Birmingham, 10, incorporates an infuser moulded in Rigidex polythene which is resistant to boiling water and staining.

(Right) The Nylock moulded in nylon by Hellermann Ltd., Crawley, Sussex, can be used amongst other applications, for a door catch, shelf support, coat hook or door stop.



(Left) Nylon three-speed gear manufactured for Resilion Ltd. is moulded to exceptionally close tolerances by Pendry Plastics Ltd., Bridge Works, Brentfield Road, London, N.W.10.

(Below) Salad servers moulded on the Continent in Grilon nylon.



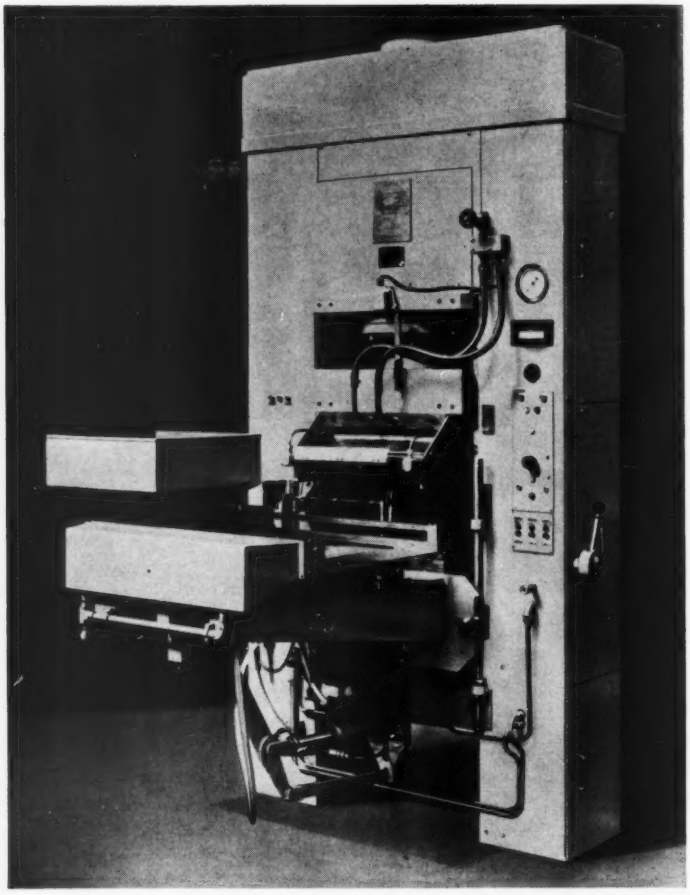
(Right) By vacuum packing their Caerphilly cheese in Polycell, polythene coated cellulose film manufactured by British Cellophane Ltd., R. G. Barker Ltd., of Shepton Mallet, are able to retain the flavour of the cheese over a longer period.

Machines for the Industry

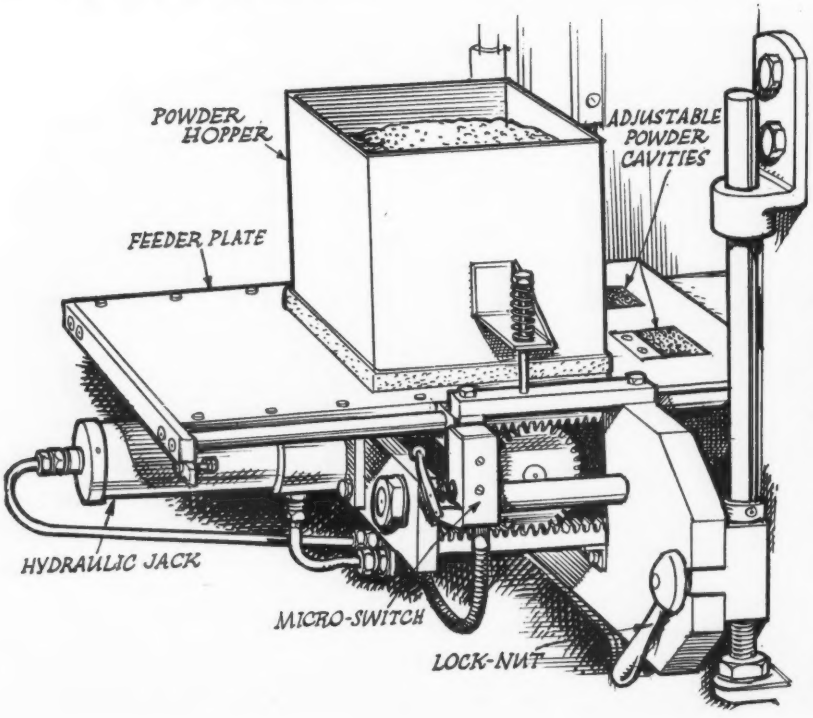
Bipel Fully Automatic Compression Presses

THE Bipel fully automatic compression moulding machines, developed from the well-known range of semi-automatic presses, fill a long felt need in the industry. Basically the automatic press is an adaptation of the standard Bipel machine to which are added a power loading attachment on the front, with top or bottom stripping on the rear. Both units are mounted on ground vertical pillars and may be swung to one side simply by releasing a lock nut, thus affording immediate access to the tool, or allowing normal semi-automatic working. The semi-automatic equipment and ejector gear associated with this kind of press is included.

The introduction of these machines makes the fully automatic moulding of comparatively short runs an economical proposition owing to the rapidity with which a change over of moulds can be effected. To facilitate even faster tool changing, a series of standard bolsters has been designed so that within quite a wide range of jobs it is possible to use standard size impressions or cavities and it is unnecessary to remove the bolster from the press. By this method, tool change has been accomplished in under one hour but even when the whole tool is replaced, the change-over should not take more than three to four hours. The powder cavities in the loading attachments are adjustable so that provided the impressions are on the same centres, there is no need to change the feeder plate. In the event of using a different number of impressions the changing of the feeder plate is quite simple and requires very little time.



(Above) Bipel press equipped for automatic moulding with pellets. Bipel machines are manufactured by B.I.P. Engineering Ltd.



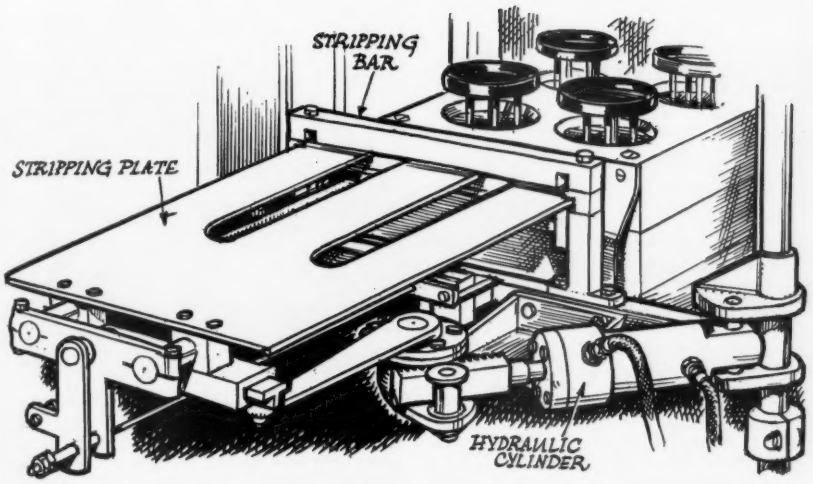
(Left) Automatic powder feeding to the mould cavities is shown in this drawing; the equipment meters the correct quantity of material for each cavity.

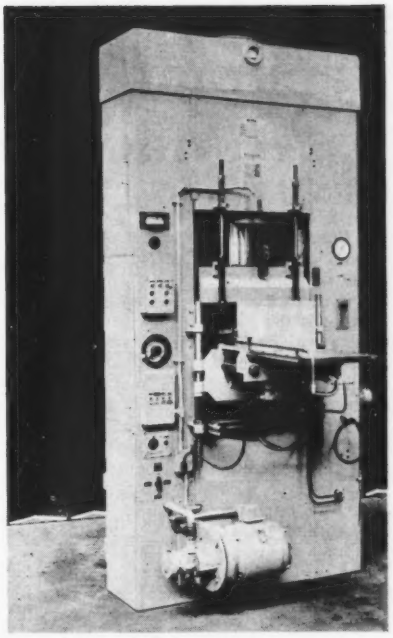
For jobs requiring pellets special apparatus is supplied which affords equally fast loading for multi-impression tools.

The feeder plate is actuated by a hydraulic jack by means of rack and pinion mechanism. The rack and pinion magnifies the motion of the feeder plate by a factor of 2 so that a short stroke jack can be used. This jack is positioned under the plate and does not project beyond the feeder, an arrangement which reduces the overhang to a minimum.

Provision is made for ejection from either top or bottom, whilst hold down pins are incorporated in the top table to ensure that the moulding will stay in the bottom impressions when bottom ejectors are used.

Two stripping plates, top and bottom, are hydraulically operated and impart simple





(Above) Mechanism of the stripping movement showing the lower plate. (Right) Bipel press with automatic attachment for powder feed.

harmonic motion to the plates, resulting in gradual acceleration and deceleration.

In every case the machine is fitted with a safeguard to prevent double loading. The fully automatic gear is sequence controlled and the Bipel feature of a flexible drum controller is incorporated to give a precise control over the most complex moulding procedure.

New Plastic Welding Machine

A description of the 311 PW machine designed and manufactured by Metropolitan-Vickers Electrical Co., Ltd.

THE type 311 PW plastic welder is a new and advanced design of welder which embodies a new self-bedding electrode system.

The design enables a wide range of products to be welded from materials of a few thousandths of an inch thick to thicker sheets such as those used in the manufacture of toys. The welding time varies, of course, with different applications but a built-in process timer ensures accurate repetition of any pre-set cycle.

The machine is intended for use by unskilled labour and the operation is consequently as simple and automatic as possible. The closing of the lid applies the welding power for the pre-set time, at the end of which period the lid automatically opens and switches off the power. It is impossible for the operator to shorten the welding cycle except, in emergency, by operating the main "on-off" switch. Since there is then a time lag before power can be restored, this method cannot be used by an operator to increase production at the expense of the quality of the weld.

The only exposed control is the "on-off" switch, but "power-on" and H.T. warning lights are conveniently mounted.

The fuses, overload relays, time selector, and output selector, and output selector switch are mounted on a panel behind a locked panel accessible only to an authorized person. All these controls have been grouped to provide a rapid and simple setting up procedure. Anode current and grid current meters are also provided to facilitate this operation.

The new type of electrode system used in the 311 PW avoids the need for precision machines electrodes. The cost of replacing or making new shapes of electrodes has been reduced to negligible proportions, and a new electrode can be made by hand in a few minutes. The bottom electrode is built into the machine and consists of a rectangular flexible pad, the shape of the weld being determined by a loose top electrode which is simply made up of a strip of aluminium. The work to be welded is placed on the flexible pad, the loose electrode is placed in the desired position, and the lid is closed. The closing of the lid connects the loose electrode in circuit, applies the necessary pressure, and switches on the electrical power. The flexible pad enables the electrode to bed down perfectly without risk of pitting or arcing, and ensures full contact with the work with no danger of unwelded sections of seams.

The fullest importance has been paid in the design of the 311 PW to the reliability of the machine and to the safety of the operator. Very little maintenance will be necessary apart from the routine replacement of exhausted valves. To reduce the loss of production time to a minimum the side panels are easily removable, while the rectifier valves and grid lamps can be exchanged by removal of one panel held in position by two locks. The relays can also be adjusted from this point.

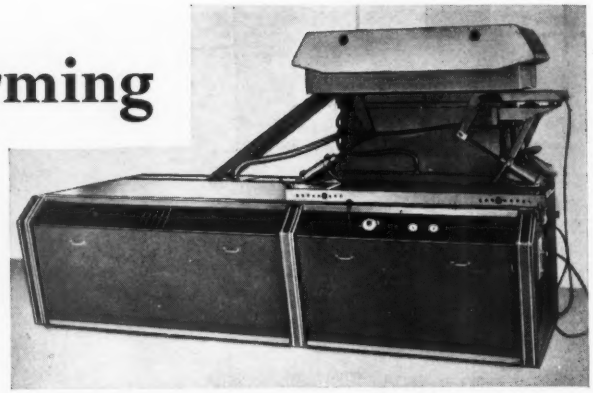
All possible safeguards have been taken to ensure safety for personnel and all panels and covers are interlocked with the electrical circuit.

The maximum length of straight electrode is 24 in. This figure is the diagonal measurement of the bottom welding pad. Shaped electrodes of a greater length can of course be used.

New plastic welding machine introduced by Metropolitan-Vickers Electrical Co., Ltd.

Machines for the Industry

Vacumat Vacuum Forming Machines



Type S 1,300/1,000 × 500 showing mould box and heating screen in position.

IN the July issue of *Plastics* we published a photograph of a vacuum forming machine which is being used by Lec Refrigeration for the forming of refrigerator liners. This machine is the Vacumat and we believe that readers will be interested in knowing more details of the range of this type of vacuum forming machine.

There are four designs of Vacumat machine. They are Type E, with one working position and the heater moving forward; Type S with one working position and the heater moving laterally; Type T with two working positions located on opposite sides; and, Type N with two working positions located on the same side.

The base of the machine contains the control unit and compressed air cylinder for operating the heater and mould carrier; the vacuum tank and vacuum pump, which is air cooled and has an efficiency rating of approximately 95%; and the electrical apparatus.

The heater has a series of small infra-red radiators incorporated in it in a chessboard pattern. Each of these has its own on/off control enabling various heating patterns to be obtained. When not in use the lever action holds the panel over a neutral area which can also serve as a pre-heating table.

The Vacumat can be used for most types of forming the most popular being a drape forming technique with a pneumatic pre-forming operation in which the sheet is blown and then the mould lifted into the blown sheet before the vacuum is applied. This process requires the use of a mould box of which two types are available one the type S having a depth of 500 mm. and the other, the type L, having a depth of 250 mm. Both have pneumatically operated clamping frames and locks and can be fitted with a swing-type auxiliary die. The mould carrier which lifts the mould is raised by means of a pneumatic/hydraulic system.

There are several additional pieces of equipment that can be applied to the standard model. This model is semi-automatic in operation having a controlled automatic cycle for the heater movement and timing but hand control for the pre-stretching, mould raising, vacuum applying and subsequent operations. To make the machine fully automatic, programme control equipment can be fitted and the full cycle except for loading the sheet and removing the moulding is automatic.

Other special equipment includes hot-air pre-stretching equipment and a mould temperature control unit. This latter is a mobile unit in which water at a constant temperature is circulated through the mould. Finally the infra-red radiators in the heater panel can be fitted with individual controllers which enable the heat intensity to be controlled over specific areas.

Further details of this range of machinery can be obtained from the British Agents, Southern Tools Ltd., 22/24 Upper Mulgrave Road, Cheam, Surrey.

Size	Maximum sheet size (mm.)	Power consumption (kW.)
600/ 500 x 250*	600 x 500	6
750/ 600 x 250*	750 x 600	8.5
1,000/1,000 x 250*	1,000 x 1,000	20
1,300/1,000 x 250*	1,300 x 1,000	25
1,500/1,000 x 250*	1,500 x 1,000	30
1,800/1,000 x 250*	1,800 x 1,000	34

* Mould carrier lift 250 mm. in standard model, 500 mm. in special design.

Vacuum Coating Unit

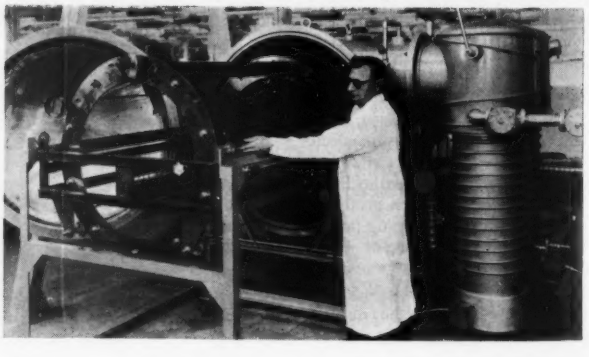
THE latest addition to the range of production vacuum coating units produced by Edwards High Vacuum Ltd., Manor Royal, Crawley, Sussex, is a 48 in. model and one has just been completed for export to South Africa. This was equipped with a special pumping system, designed for metallizing plastics at high production rates.

The 48 in. coating unit itself is built to a standard design and comprises a mild steel work chamber with an internal diameter of 48 in. and a length of 54 in. Observation windows are fitted in the door and the chamber side and these are fitted with special wipers and shields. Rails are provided in the chamber to carry the evaporation jigs and filament arrays, and two sets of removable stainless steel liners avoid the necessity of cleaning aluminium deposits. A ½ h.p. motor is mounted on the chamber door to provide a speed of 30 r.p.m. in the chamber for the jig mechanism.

Vacuum measurement is provided by a Penning type cold cathode ionization gauge and Pirani thermal type gauge and these are incorporated in a control cabinet with vacuum switches and indicating lamp for the pumping system. The power unit is mounted separately on a mobile chassis and comprises a Variac transformer and step down transformers, together with a mains switch and meter.

Two rotary work holders were provided with the South African plant, each consisting of nine vanes 10 in. in diameter × 48 in. long mounted in a circular frame. During evaporation the vanes are rotated so that the objects they carry are evenly coated. The frame carries three filament bars, the two outer being connected to the electrodes and the inner to earth. The outer bars each carry four and the centre bar eight adjustable filament clamps thus enabling two banks of four filaments in parallel to be mounted as desired.

The feature of this 48 in. plant is the great versatility of pumping equipment which can be varied to suit the work to be processed. This particular unit was provided with two 16 in. oil diffusion pumps connected to the chamber by right-angle isolation and baffle valves, each pump having a peak baffled speed of 3,000 litres/second and being capable of an ultimate vacuum of 5×10^{-6} mm.Hg. These diffusion pumps were backed by an 18B3 booster vapour pump which in turn was connected to the roughing pump, a 200 cu. ft. per minute rotary model. The complete combination has an exceptionally high pumping speed over the whole pumping cycle from atmosphere to evaporation pressure and with an unloaded work jig in the chamber evaporation pressure could be reached in 4½ minutes.



One arm of the rotating jig assembly loaded with plastic egg cups during a test run of the 48E plant.

Plastics News

Plant and Equipment, Materials, Processes, Company News, Technical Literature, Exhibitions, Personal Notes and Meetings.

SMALL INJECTION MACHINE.—The Arburg Plastic Injection Moulding Machine has been particularly developed to answer the requirements of engineers requiring experimental runs or economic production runs of small parts involving low mould costs and utilizing most of the plastics being used today.

Its rigid construction of cast iron and steel embody quick setting up, speedy exchange of moulding cylinders and pistons, automatic closing nozzle, temperature regulation and dosage unit, make it a versatile and simple machine for production running.

The plasticizing capacity is 4.8–8.4 lb. per hour, depending on the material being used, enabling as many as eight shots per minute or shots of six gram capacity, to be maintained for lengthy periods.

The power consumption is low, being of 300–500 watts, and water cooling jackets are embodied in the machine for long production runs. It is available as a hand operated, as well as a hydraulic pneumatic and automatic machine. In the latter case, both the operation of the machine and of the mould opening and closing can be effected automatically.

A full technical service is available in order that manufacturers may be advised of the probability of using plastics to replace their existing materials used in production. Articles such as cog wheels, gear-changing cams, electric plug assemblies, metallic lettering, seal stamps, toys, and bonding of plastic parts on to existing metals or materials can be simply produced.

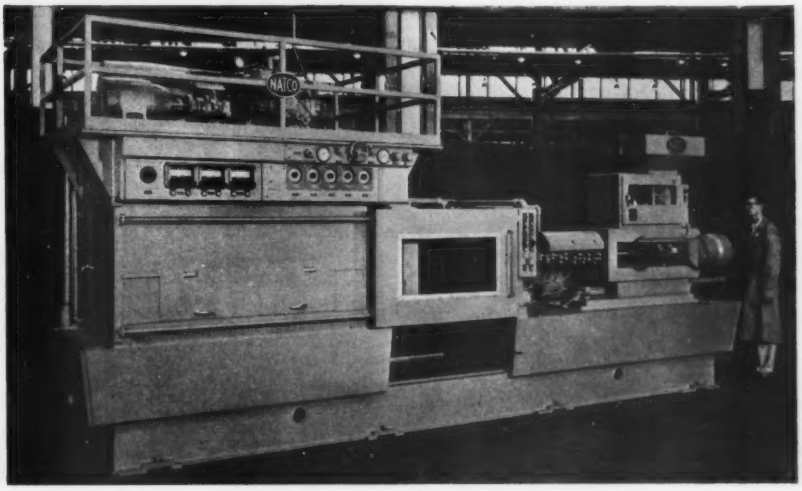
Further details can be obtained from Engis Ltd., Gabriel's Hill, Maidstone, Kent.

NEW AMERICAN INJECTION MACHINE.—The Natco 300 plastics injection moulding machine is the second entry in the field of plastics machinery by the National Automatic Tool Co., Inc., of Richmond, Indiana.

In announcing the "300," the builder pointed out that it is designed to mould all commonly used thermoplastic materials and features the same "shockless" closed-circuit hydraulic system as the larger Natco "400," which was reported in *Plastics*, December, 1957.

The "300" will single-plunger feed 22 oz. of general purpose polystyrene. Its capacity in low density polythene is 12 oz.-single feed, 21 oz.-double feed. According to Natco engineers, the new moulding machine is designed to cut idle time to a minimum. It can attain maximum clamping pressure of 325 tons in less than a half-second. Rated plasticizing capacity in general purpose polystyrene is 130 lb. per hour. It has interchangeable injection plungers and feed bushings for either 20,000 or 30,000 p.s.i.

The 325 ton mould clamp has a maximum 24 in. stroke with as much as 42½ in. of daylight. This permits moulding of deep parts—up to 12 in. deep for rigid materials and up to 15 in. deep for flexible plastics. The 33 × 33 in. platen will accommodate moulds up to 33 × 21¼ in. in size.



The new Natco 300 injection moulding machine.

General

Cellular Plastics Production in U.S.A. Doubled in 1957.—The production of Cellular Plastics reached 31,500,000 lb. in 1957 according to Joseph R. Morton, newly elected Chairman of the Cellular Plastics Division of The Society of the Plastics Industry, Inc., and President of Morton-Withers Chemical Co., Div. of Chas. Pfizer & Co., Inc., Greensboro, No. Carolina. This represents a production increase of approximately 97% compared to 1956.

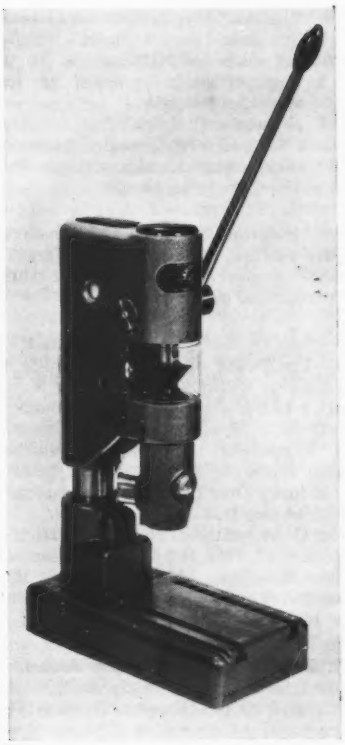
Cellular Plastics or foamed plastics are produced from basic resins such as vinyl, urethane, polystyrene, phenolic, and polythene.

Mr. Morton also predicted that total cellular plastics production will amount to approximately 50,250,000 lb. in 1958, or a gain of 59%.

It is estimated, according to Mr. Morton, that flexible and rigid vinyl foam production which amounted to approximately 4,500,000 lb. in 1957 will exceed 5,250,000 lb. during 1958.

Flexible and rigid urethane foam which amounted to about 12,000,000 lb. in 1957 should double production to approximately 25,000,000 lb. by the end of 1958.

Rigid polystyrene foam production was estimated at 15,000,000 lb. in 1957. It is expected that this figure will approach 20,000,000 lb. in 1958.



The Arburg injection machine.

Pinch Valve.—The Rowe Pinch Valve is available in sizes from 1 in. to 3 in. bore diameter.

For the first time in this type of valve, die-cast construction has been used both for the casing and internal parts. At the same time, specially designed reinforced sleeves are used exclusively, all of which are suitable for internal pressures up to 100 p.s.i.

The closing mechanism consists of two die-cast aluminium alloy anvils, a screwed spindle, and a handwheel which operate to compress the sleeve equally from both sides.

The reinforced sleeves are available in four

grades of natural or synthetic rubber materials:

1. For general purpose duties.
2. For alcohol and milk.
3. For petroleum products, tar and ammoniacal liquors.
4. For abrasive materials.

Sleeve No. 2 has been specially compounded to withstand repeated steam scalding where food products are being handled.

Price Reduction.—Bakelite Ltd. announce a reduction of 2½d. per lb. in the U.K. prices of standard grades of their polythene resins, compounds and master batches.

Synthetic Organic Chemicals Added to K.I.D. List.—The Board of Trade have made the Safeguarding of Industries (Further Supplementary List of Synthetic Organic Chemicals, etc.) Order, 1958, introducing a supplementary list (" Key Industry Duty List K ") of synthetic organic chemicals, etc., which are liable to Key Industry Duty under the Safeguarding of Industries Act, 1921.

The Order, which came into operation on September 27, 1958, is S.I. No. 1584, and can be obtained from H.M. Stationery Office, Kingsway, London, W.C.2, and branches, price 3d., by post 5d.

St. Lawrence Telephone Cable Project.—A contract worth approximately £900,000 has been placed by the Canadian Overseas Telecommunication Corporation of Montreal with Submarine Cables Ltd., owned jointly by Siemens Edison Swan Ltd. and The Telegraph Construction & Maintenance Co., Ltd., for a submarine telephone cable system between Newfoundland and the mainland of Canada.

A cable of coaxial type will be used. The inner conductor will be solid copper rod, and the outer conductor will comprise six copper tapes, held in position by a copper binding tape. Polythene, admixed with small percentages of butyl rubber and antioxidant, will provide the insulation.

Price Reduction.—A. Boake, Roberts & Co., Ltd., 100 Carpenters Road, London, E.15, announce a further plasticizer price reduction. Trixylyl Phosphate is being reduced by £15 a ton to a new minimum price of £201 in 10-ton tankers.

Heavy-Duty Valves.—Martonair Ltd., Parkshot, Richmond, Surrey, announce the introduction of an entirely new series of pneumatic control valves.

The valves, which are suitable for heavy duty in all industries, are made in both three-port and five-port form, in ¼ in., ⅜ in. and 1 in. BSP sizes.

The four operating mechanisms—single pressure with air return, double pressure, lever with air return and three-position lever—are interchangeable between themselves and between different sizes of body.

Powder Blending Machine.—The illustration on this page shows one of the largest powder blending machines ever to be made in the United Kingdom, at the works of the Sturtevant Engineering Co., who designed and manufactured the unit. It is destined for the new Acrilan factory being built in Northern Ireland by Constructors John Brown Ltd., where its purpose will be to obtain a homogeneous blend of very fine polymer powders.

The unit is approximately 25 ft. long overall, 13 ft. high and 12 ft. wide. It has an uncharged weight of approximately 17 tons, and is capable of blending single batches of up to 450 cu. ft. in volume.

The shell and all material contact surfaces are lined in corrosion-resistant material, and the entire machine is arranged for internal purging with inert gas. The intake and discharge box forms a unit at one end of the machine, the charging and discharging mechanism being motorized for remote control.

The highly efficient action of the unit is obtained by both a cascade and lateral movement of the material, the lateral distribution being obtained by pivoted chut plates fitted with differential linkages.

Sales of Plastics Materials in the second quarter of 1958.—Sales of plastics materials in the second quarter of this year were 97,900 tons or nearly 2% below the second quarter of 1957. The particularly fast growth in sales that occurred in the first three-quarters of 1957 began to level off towards the end of last year; although sales have now fallen below those of a year ago, they are still well above those of 1956. Because of the stock build of plastics materials in the second quarter of this year, the estimated rate of production remained high, and was about 4% above a year earlier.

Sales of thermosetting materials at 42,100 tons were 2% lower than a year earlier and the rate of production was also down about the same amount; stocks at the end of the second quarter at 16,000 tons were the same as a year earlier.

Sales of thermoplastic materials at 55,800 tons were about 1% below a year earlier; however, there was a fairly large stock build in the second quarter and production was maintained at about the same high rate as in the previous six months, and well above that of a year earlier. Stocks of thermoplastic materials at the end of the second quarter of this year at 36,900 tons were 12,100 tons higher than a year earlier. 10,400 tons of this stock increase over the year was in " other thermoplastic materials " (from 12,800 tons to 23,200 tons) and stocks of polystyrene moulding and extrusion compounds increased in the year by 1,100 tons (to nearly 5,000 tons); in polyvinyl chloride materials (other than resins) stocks of moulding and extrusion compounds increased in the year by 400 tons (to 2,500 tons) though in the more highly finished materials the overall stock changes were not large.

Exports of all plastics materials in the quarter were nearly 25,000 tons, a fairly high level, although lower than in recent quarters. Imports at 8,700 tons were also fairly high although below the record levels of the previous two quarters.

NET SALES AND STOCKS OF PLASTICS MATERIALS
Thousand Tons, 2nd Quarter, 1958

NET SALES	
THERMOSETTING MATERIALS	
Alkyds	11.4
Aminoplastics	12.1
Phenolics and cresylics	15.9
Polyesters	1.1
Other (including casein)	1.6
Total thermosetting materials	42.1
THERMOPLASTIC MATERIALS	
Cellulose plastics	2.7
Polyvinyl chloride (*a*)	17.2
Polystyrene	8.1
Other (*b*)	27.8
Total thermoplastic materials	55.8
Total all plastics materials	97.9
STOCKS AT END OF PERIOD	
Thermosetting materials	16.0
Thermoplastic materials	36.9

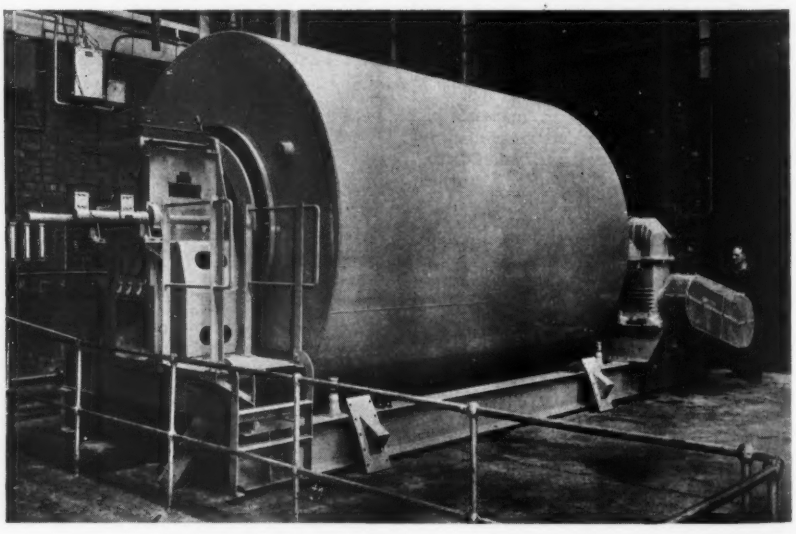
Note: Any apparent discrepancies are due to rounding of figures.

(*a*) Excluding sales of resins (i.e. polymers sold as such).

(*b*) Including acrylics polyamides, polytetrafluoroethylene, polythene, polyvinyl chloride resins (i.e. polymers sold as such), polyvinyl acetates.

Twelve New Perspex Colours Introduced.—Twelve new colours have recently been added to I.C.I.'s Perspex range. With the removal of five colours next year the range will then consist of 57 colours.

Mario Armengol, the well-known artist and designer, has co-operated with Plastics Division in selecting the new colours. These colours, in translucent form, are representative of the groups not available in the present range.



Powder blending machine for new Acrilan factory.

Three—bright orange, red and green—have been chosen for outdoor illuminated sign applications. They are designed to give an attractive effect both by reflected and by transmitted light, and they incorporate pigments and techniques which have been introduced in recent years.

Antifoam Emulsion.—Midland Silicones Ltd. have announced that they are marketing a new antifoaming agent. Named MS Antifoam Emulsion RD, it is extremely easy to use and will disperse quickly in cold water, or may be added direct to a foaming system without prior dilution. As well as having excellent thermal stability, it is effective in very small concentrations and is particularly economical in use.

Conferences

Oil and Colour Chemists' Association 1959 Conference.—It is announced that the biennial Conference of the Oil and Colour Chemists' Association will take place in Edinburgh from May 5 to 9, 1959. The Members and visitors attending will assemble on the evening of May 5 and the technical sessions will take place on the morning of May 6, 7 and 8. The Conference disperses on May 9. The papers will be arranged under the general title of "A Survey of Polymers" and details regarding the papers to be presented will be published later.

Forms of registration will be circulated to Members of the Association at the beginning of 1959, and non-members wishing to attend the Conference should send their requests before December 20, 1958, to R. H. Hamblin, M.A., F.C.C.S., General Secretary, Oil and Colour Chemists' Association, Memorial Hall, Farringdon Street, London, E.C.4.

Young People's Lecture.—The Fifth Young People's Lecture organized by the Plastics Institute will be held on Friday, January 2, 1959, in the Lecture Hall of the Institution of Electrical Engineers, Savoy Place, London, W.C.2.

On this occasion Mr. El Rushton, B.Sc., A.M.I.E.E., of the National Physical Laboratory will be talking on "Plastics and Electricity." The lecture will be illustrated by slides and demonstrations. Tickets are obtainable from the Secretary, the Plastics Institute, 6 Mandeville Place, London, W.1.

Careers Conference.—A Conference for Headmasters and Careers Masters from schools supporting the Public Schools Appointments Bureau will be held at the Borough Polytechnic, Borough Road, London, S.E.1, on Friday, January 9, 1959. Further details may be obtained from the Secretary, the Plastics Institute, 6 Mandeville Place, London, W.1.

Tenth Annual Lecture.—The Tenth Annual Lecture of the Plastics Institute will be given by Mr. C. P. Chambers, C.B.E., C.I.E., Deputy Chairman, Imperial Chemical Industries Ltd. His subject will be "International Competition in the Chemical Industry." The date and venue will be announced later.

Company News

Semtex Ltd. have obtained a contract to supply 100,000 sq. ft. of Semtex vinyl asbestos flooring for the new American Embassy in Grosvenor Square.

Change of Name.—Play-Fab Ltd. will henceforth be known as Middleton Plastics Ltd., with Registered Offices at 117 Bath Road, Cheltenham. The directors are Frank A. Middleton and Michael F. Middleton.

Campbell & Co. (Manchester) Ltd.—The business of designers and manufacturers of these well-known mixers and agitators has recently been acquired by Messrs. Autodrome (Engineers) Ltd., of Shepley Works, Audenshaw, Nr. Manchester, who have purchased the entire manufacturing rights, patents, plant and goodwill.

The Dow Chemical Co. has announced formation of a new overseas subsidiary company in Venezuela to handle its international operations.

The wholly-owned subsidiary, Dow Chemical International Ltd., S.A., will consolidate overseas sales of Dow products and administer Dow business interests and investments abroad.

Japanese Styrene Plant.—A senior staff engineer of Asahi-Dow Ltd., in Tokyo, said a new styrene monomer plant, now under construction by Asahi-Dow, will supply the existing raw material needs for polystyrene production in Japan with additional capacity available for synthetic rubber production.

The new plant is located at Tokyo Bay's huge refining and petrochemical centre in Kawasaki, an industrial complex sandwiched between Tokyo and Yokohama. The plant is expected to go on stream early in 1960.

Rubber Plastics Ltd.—The largest German company processing the polyurethane group of rubber, Lemforder Metallwarengesellschaft m.b.H., has with Camp Bird Industries and Knight Lockhart & Co., Ltd., formed a company in England, Rubber Plastics Ltd. The shareholding is equally divided between the German and the British participants. The Board will consist of Lord Keyes, D. J. Ulderop, A. W. M. Hartley, Major J. C. du Parc Braham, R. K. Reynolds, Dr. G. Reuter and R. R. Pappier.

These new polyurethanes will be manufactured and marketed under the trade names of Vulkollan (the registered trade mark of Bayer Leverkusen) and Rublastic and will be manufactured and processed at Rubber Plastics Works, at Upper Basildon, Berkshire. Production is due to start at the end of this year.

G. Beaton & Son, Ltd.—The Directors of G. Beaton & Son, Ltd., announce that they have received from The George Cohen 600 Group Ltd. an offer to purchase at the price of 4s. per share the whole of the 1,600,000 issued shares of 2s. 6d. each in the capital of the Company.

The Directors will recommend this offer to the shareholders for acceptance and have agreed to accept it in respect of their own holdings.

R. H. Windsor (Holdings) Ltd., Proprietors of R. H. Windsor Ltd., announce that they have acquired a majority shareholding in Webley & Scott Ltd. The following Board changes are announced:—**Mr. A. C. Griffiths,** the former Chairman of Webley & Scott Ltd., retires from the Board and becomes Life President of that Company. **Mr. Arthur G. Dennis, LL.M.,** Chairman of The Windsor Group of Companies, becomes Chairman of Webley & Scott Ltd. **Mr. R. E. G. Windsor,** Managing Director of The Windsor Group of Companies, joins the Board of Webley & Scott Ltd. **Mr. C. Norman Baker, F.C.A.,** is appointed a Director and becomes Secretary of Webley & Scott Ltd. **Mr. F. V. Wynn** has resigned from the Board of Webley & Scott Ltd.

Aeraspray Assoc. Ltd. have moved their London offices to 82 Victoria Street, London, S.W.1.

U.A.M. Plastics Ltd.—The telephone number of the Head Office of the U.A.M. Group is now Watford 34551.

I.C.I. and Celanese Corporation of America.—The new company formed by Imperial Chemical Industries Ltd. and Celanese Corporation of America for the purpose of manufacturing in the United States a polyester fibre that is chemically the same as Terylene will initially be known as the Lindum Fibres Corporation.

The Board of the new company has been constituted as follows: From Celanese Corporation of America—J. H. Black (president), Dr. R. T. Armstrong, J. W. Brooks and G. H. Richards. From I.C.I.—E. A. Bingen, Dr. A. Caress, Dr. E. D. Kamm and C. I. Rutherford.

Mr. E. A. Bingen is the I.C.I. director responsible for I.C.I.'s interests in the Western Hemisphere and Africa; Dr. Caress is the Chairman of I.C.I.'s Fibres Division and Dr. Kamm and Mr. Rutherford are Directors of that Division.

British Oxygen Plant.—A new factory for the manufacture of oxygen and dissolved acetylene has been opened by British Oxygen Gases Ltd. on the Raynesway Industrial Estate at Derby. The Company now has 46 oxygen producing and compressing centres and 20 for dissolved acetylene in operation throughout the country.

Acheson Industries (Europe) Ltd. have moved to 1 Finsbury Square, London, E.C.2. Telephone: Monarch 5811.

Mr. W. E. Huggett, works manager, Petrochemicals Ltd., explains the lay-out of the 120-acre site at Partington, near Manchester, which was visited by Mr. F. J. Erroll (left), parliamentary secretary, Board of Trade, on Friday, September 26. With him is Lt.-Col. W. H. Bromley-Davenport, M.P. for the Knutsford Division of Cheshire.

Dr. R. F. Webb

Midland Silicones Ltd.—The London head office of Midland Silicones Ltd. has opened in new and more spacious premises at 68 Knightsbridge, London, S.W.1. The new telephone number will be Knightsbridge 7801.

Wild-Barfield Electric Furnaces Ltd.—The telephone number of Wild-Barfield Electric Furnaces Ltd. of Watford has been changed to Watford 26091.

R. H. Cole & Co., Ltd., announce by mutual arrangement with Dunstan Hill Chemicals Ltd., that they have taken over the exclusive distribution in the United Kingdom for plastic sheet, films and foils manufactured by Rheinische Gummi, Mannheim-Neckarau 17a, Germany.

Witco Chemical Co., Ltd., announce that their Scottish office has now been transferred to more commodious premises at 62 Robertson Street, Glasgow, C.2.

Plastic Firms to Expand.—A major expansion programme is being undertaken by Tootal Ltd. on behalf of their wholly-owned subsidiaries Thermo Plastics Ltd. and Mendip (Chemical Engineering) Ltd.

A large factory at St. Helens is being equipped with the latest machinery and facilities, and extensions are also being planned at the Dunstable factory.

A large proportion of the extra production space now being provided will be devoted to the enlargement of the vacuum forming and sheet moulding divisions of Thermo Plastics Ltd.

New German Instruments.—Under this heading, on page 377 of the October issue, reference was made to a German instrument, the Decameter, for resistance measurements. The word "Megger" employed in the text was incorrectly used, since this is the registered trade mark of Evershed and Vignoles Ltd., London, W.4.

Birfield Ltd. announce that they have acquired a controlling interest in A. E. Callaghan & Son, Ltd., of Midhurst, Sussex, makers of fibre amalgamating machines. In future these machines will be manufactured by Birfield Tools Ltd., of Coventry, and research and development will be carried out in conjunction with Railko Ltd., of High Wycombe, and other members of the Birfield Group of Companies.

Personalities

Mr. H. E. Cooper has been appointed Managing Director of G. A. Harvey & Co. (London) Ltd. Mr. Cooper, first appointed to the Board in 1946, has been acting as Deputy Managing Director since May of this year. **Mr. I. A. Marriott** succeeds Mr. P. T. Bliss as Sales Director. Mr. Bliss, who has been with the Company for 50 years, retires on December 31.

Golf Results.—The results of the P.I.G.S.. meeting held at West Hill Golf Club on October 7 were as follows: *Airborne Trophy:* Winner, F. A. Garrett; runner-up, R. P. Anderson. *Captain's Prize:* Winner, F. A. Garrett; runner-up, T. V. Boardman. *Visitor's Prize:* Morning, S. Wilkinson; afternoon, R. Cooke.

Mr. C. Musgrave, of The Geigy Company's Plastics Division, gave a paper on Plastics and their Colouring to the London Section of the Society of Dyers and Colourists at Burlington House, London, on October 3, 1958.

Dr. F. M. Herzberg retired from the Board of Hornflowa Ltd. on September 30, 1958. Joining the Company at its inception in 1939 as a Director, he has been sole Managing Director since 1943, and his decision to retire has been influenced by the approach of his 72nd birthday. He has declared his willingness to be available to the Company in a consulting capacity in the future.

Mr. Richard Turner has been appointed a Managing Director of Johnson, Matthey & Co., Ltd. He relinquishes his position of Managing Director of Mallory Metallurgical Products Ltd., a subsidiary company, but remains a Director.

F. A. Spence-Brown.—It is with regret that we hear of the death of Mr. F. A. Spence-Brown, a joint managing director of Johnson Matthey & Co., Ltd.

Mr. J. H. Smith has been appointed Export Manager of Formica Ltd., London. Before this appointment Mr. Smith, who is a member of The Incorporated Sales Managers' Association, was Export Sales Manager of the Halex & Bex Division of the British Xylonite Co., Ltd.

Mr. F. J. Havenith.—George Kent Ltd. announce the recent appointment to the Board of their Belgian Subsidiary Co., Kent-Continental S.A., of Mr. F. J. Havenith as local Resident Director.

Mr. C. N. Taylor has been appointed Home Sales Manager of British Titan Products Co., Ltd.

R. F. Webb, B.Sc., Ph.D., formerly a lecturer in National Sciences at Cambridge University and a Fellow of Trinity Hall, Cambridge, has joined the staff of CIBA (A.R.L.) Ltd., Duxford, where he will direct the activities of a number of specialist groups engaged in long-term research in new plastics materials.

Sir H. W. Hugh Warren has been appointed a director of British Industrial Plastics Ltd.

Dr. E. W. Smith recently relinquished his executive duties with The Telegraph Construction & Maintenance Co., Ltd., after 48 years' service.

Malcolm MacFarland.—We learn, with deep regret, of the death of Malcolm MacFarland on October 16. He was co-founder, with E. J. Wilkins, of our contemporary, *British Plastics*, and played a leading part in the early growth of the industry, the Institute and the Federation. He was also an early Trustee, and later Chairman, of the Benevolent Fund. "Mac" was a widely loved man and will be mourned by all his colleagues and friends.

Meetings

November

14th.—Joint meeting of the North Western Section of the Plastics Institute and the Merseyside Section of the Institution of the Rubber Industry, at the Adelphi Hotel, Liverpool. 7.30 p.m.

18th.—"Commercial and Cost Considerations in Injection Moulding," by A. B. Merriam. A Junior Lecture of the London Section of the Plastics Institute, at the Wellcome Building, 183–193 Euston Road, London, N.W.1. 6.30 p.m.

19th.—"Various Uses of Terylene Fibre," by D. Seggie. The North Eastern Section of the Plastics Institute, in the Second Dining Room of the Eldon Grill, Grey Street, Newcastle. 7 p.m.

21st.—"Plastics in the Building Industry," by R. P. H. Gillett. The Midlands Section of the Plastics Institute, at the James Watt Memorial Institute, Great Charles Street, Birmingham, 3. 6.30 p.m.

December

2nd.—"Precision Polymers," by Dr. C. H. Bamford. A joint meeting of the Plastics and Polymer Group and the Birmingham Section of the S.C.I., at the Birmingham and Midland Institute, Paradise Street, Birmingham. 6.30 p.m.

3rd.—"The Characterization of Short Chain Branches in Hydrocarbon Polymers," by D. A. Boyle, W. Simpson and Dr. J. D. Waldron. The Plastics and Polymer Group of the S.C.I., at the S.C.I. Meeting Room, 14 Belgrave Square, London, S.W.1. 6.30 p.m.

4th.—"Molecular Structure and Properties of Plastics," by A. W. Birley. A joint meeting of the Southern Section of the Plastics Institute with the Mid-Southern Counties Section of the Royal Institute of Chemistry, in the Chemistry Department, University of Southampton. 7.30 p.m.

5th.—Day Symposium of the North Western Section of the Plastics Institute, at Newton Heath Technical College, Manchester.

5th.—"Some Aspects of the Application and Fabrication of Industrial Laminates," by S. F. Sandford. The North Western Section of the Plastics Institute at the Textile Institute, Blackfriars Street, Manchester. 6.45 p.m.

5th.—The Annual Dinner Dance of the Western Section of the Plastics Institute, at the Plough Hotel, Cheltenham. 6.45 p.m. for 7.15 p.m.

8th.—"The Radiation Curing of Rubber and Plastics," by R. M. Black. A joint meeting of the South Wales and Monmouthshire Sections of the Plastics Institute and the Institution of the Rubber Industry, at the Angel Hotel, Westgate Street, Cardiff. 6.30 p.m.

10th.—Film Evening of the North Eastern Section of the Plastics Institute, in the Second Dining Room of the Eldon Grill, Grey Street, Newcastle. 7 p.m.

10th.—"Butadiene Co-polymers: a Review of Recent Developments," by N. D. MacLeod. The Scottish Section of the Plastics Institute, at the North British Hotel, Edinburgh. 7.30 p.m.

10th.—"The Fabrication of Thermoplastics," by T. S. Kirkby. The Yorkshire Section of the Plastics Institute, at St. Marks House, 186 Woodhouse Lane, Leeds.

Automation Equipment

Photo-Electric Control Apparatus.—The range of apparatus produced by Erwin Sick is divided into two main basic groups. Firstly there are the devices known as Light Curtains in which a triangular or rectangular area is covered by a light beam in such a way that the device will respond to an object passing through the area at any point. Rectangles up to 27 in. in height and 20 ft. 0 in. wide can be covered in this way by a single unit.

The second range consists of the single beam apparatus of which Messrs. Sick make four fundamentally different types; two being applicable for different ranges of distance, and the other two for special applications. On all their equipment the photo-cell and light source are housed in the same box, and the light is merely reflected from the other side of the beam or curtain by means of a special reflector or, in the case of one or two special applications, by the object which is to be detected itself. Reflectors of this type have the property that the incoming ray of light will always be parallel to the outgoing ray of light, even if the centreline of the reflector is at an angle to the direction of the incoming ray of light; the reflector can therefore be tilted by amounts up to 15 degrees.

Apart from the fact that this means that the equipment on one side of the beam or curtain needs only very rough aligning, there is the additional feature that the unit on the other side can be made so as to respond only to light coming along particular paths parallel to the outgoing rays. The optical system can thus be designed that it will automatically exclude sensitivity to external light sources.

Pearson Panke Ltd., 1–3 *Hale Grove Gardens, London, N.W.*7.

Electronic Thermo-Switch.—A. M. Lock & Co., Ltd., have just released for sale to industry, their newly developed electronic thermo-switch.

The instrument is designed to maintain temperatures at a pre-set value, which gives immediate relay action for any tendency to deviate from this value. Any variation of temperature will result in the platinum sensing element producing an out of balance signal in the electrical bridge network, either in or out of phase with the bridge voltage, depending upon the sense of the temperature change. The signal is then amplified and applied to a phase sensitive detector which operates a heavy duty control relay, making or breaking, according to whether the measured temperature is lower or higher than the pre-set position on the control knob.

The temperature elements are interchangeable, and extremely sensitive, they consist of a platinum winding, housed in a thin stainless steel tube .With this new Lock electronic thermo-switch the element can be located remotely from the control unit.

This instrument has an on/off control action on a temperature differential of $\pm 0{\cdot}1\%$ of range coverage. It is available for use in temperature range $-200°$ C. to $+500°$ C. and operates with interchangeable resistance elements. A "plug-in" electronic chassis is used for ease of maintenance and quick replacement. The control setting knob is located behind the instrument door which is provided with a locking device to prevent unauthorized interference.

A. M. Lock & Co., Ltd., Prudential Buildings, 79 Union Street, Oldham, Lancs.

Digital Display Unit.—A new unique in-line digital display unit is being manufactured by Counting Instruments Ltd. Each unit comprises a system of lenses whereby a figure or letter 1 in. by $\frac{3}{4}$ in. is projected on to a screen by means of 12 lamps. The main advantage of this method is that the image always appears in the same plane, giving a very wide angle of view. The units can be banked together to give, for example, the read-out on a digital volt meter, though numerous other applications exist.

The standard model has provision of projecting the figures 0–9 and two decimal points. A number of other models are being developed showing letters, signs, and provision for either coloured characters against a black background or a coloured outline to a white character.

Counting Instruments Ltd., 5 Elstree Way, Borehamwood, Herts.

Electro-Hydraulic Actuators.—Recent trends toward electrical control loops have created a need for final control elements capable of utilizing their greater transmission speed.

Digital Display Unit.

Fisher Electro-Hydraulic Actuators are self-contained, electrically operated valve actuators, ideal for use in such control loops. They produce high performance without the use of electronic amplification, utilizing only a simple force motor to control the hydraulic pilot. The pilot system incorporates a simple nozzle-flapper combination to control hydraulic pressure.

Two sizes are available. To handle the most demanding control jobs, type 350 has a maximum stem thrust of 2,000 lb. and is available for use on valve sizes $\frac{1}{2}$ in. to 16 in. with strokes from $\frac{1}{2}$ in. to 3 in. Type 340 is designed to be used on average control jobs. It has a maximum stem thrust of 600 lb. and is available for use on valve sizes $\frac{1}{2}$ in. to 4 in., with strokes from $\frac{7}{16}$ in. to $1\frac{1}{2}$ in.

Fisher Governor Co., Ltd., Airport Works, Maidstone Road, Rochester, Kent.

(Left) The electronic thermo-switch recently introduced by A. M. Lock & Co., Ltd.

(Right) The type 350 electro-hydraulic valve actuators.

TALKING SHOP . . .

Plastics Institute Western Section.—I hear that this section of the Institute has recently been taking an active (or radioactive) interest in nuclear power stations. After a recent series of films on the construction of Calder Hall and Dounreay a party of 40 members and friends visited the Nuclear Power Station at Berkeley, Glos., last month. Mr. John Hall, the A.E.I., and John Thompson, p.r.o., explained the layout and mechanism of the station after which the party disappeared into gum boots and beneath helmets to see for themselves some of the engineering feats which are taking place on this site. All the members returned safely.

* * *

Bridge on the Motorway.—Plastics are contributing in a small way to the construction of the London–Birmingham motorway according to a note I have received from Monsanto Chemicals Ltd. Holland & Hannen & Cubitts (Gt. Britain) Ltd. are using Lustrex T.6 polystyrene sheet as a shuttering liner for casting eight reinforced concrete columns which will form the centre support of the bridge over the A.405. By using this type of lining an exceptionally smooth finish is obtained and so there is no difficulty in parting after the concrete has set.

* * *

New Plastic Gramophone Records.—From the Commercial Plastics Group comes news that Craytherm, a product of Greenwich Plastics Ltd., is being used for gramophone records. This material has previously been used for magnetic tape and the new T.V. Video Tape recordings. Reports indicate that a high standard of reproduction, on long playing life, and a low cost are features of its use. First consignment of this material for records has gone to Paris where it is to be used in the first issue of a magazine called " Sonorama." This is a new venture in " publishing " in that the magazine will contain about 40 minutes of recordings of political comment, music and interviews as well as articles and photographs.

* * *

Federation Reinforced Plastics Group.—The British Plastics Federation has now formed a new group, membership of which is open to manufacturers who manipulate reinforced plastics and manufacturers of the materials and equipment used in the production of reinforced plastics articles. Mr. H. V. Blake, who is the chairman of the group, at a recent press conference described its aims among which will be the pooling of knowledge on these materials, and the investigation of their properties for, as Mr. Blake said, " We have not yet arrived at the day when reinforced plastics achieve predictable consistent properties so that safety factors, which are really factors of ignorance, can be reduced and the cost/strength ratio improved."

* * *

Golf.—I see Mr. Frank Garrett was again on form at West Hill the other week when he won both the Airborne Trophy and the Captain's Prize. How well he played can be judged by the fact that his gross number of strokes for the two rounds was 150, a remarkable feat on a course the length of West Hill. The course bogey is 72, so our congratulations, Mr. Garrett.

* * *

Converging Thought.—That rubber and plastics are becoming more closely allied was again underlined when Mr. Jasper Frankenburg, President of the Federation of British Rubber and Allied Manufacturers, suggested, at an informal luncheon to the Federation, that the Rubber Federation might well take steps to establish some formal liaison with plastics manufacturers through which common problems might be discussed and resolved. I recall Dr. Swallow, President of the Plastics Institute, saying something similar at the Annual Luncheon this year.

* * *

Postgraduate Education in Aircraft Materials.—A Department of Aircraft Materials has now been established at The College of Aeronautics, Cranfield, so that in the future students may elect to take this subject as their main specialization in the post-graduate College Diploma course.

In addition it is intended to set up a short course on materials, of about two months' duration, which will be open to industry generally. The aim of such a course is to present to those concerned with engineering applications of materials a working knowledge of modern developments in materials theory and technology. Those interested in an advanced course of this kind are invited to write to Professor A. J. Kennedy, B.Sc., Ph.D., A.M.I.E.E., F.Inst.P., at The College of Aeronautics, Cranfield, Bletchley, Bucks., so that some assessment of the potential demand may be made.

* * *

Fellows and Associates.—The Council of the Plastics Institute have made the following elections:

As Fellows (F.P.I.); D. Gonda, Dipl.Ing., and F. A. Jones, B.Sc., F.R.I.C., F.I.R.I.

As Associates (A.P.I.); E. J. Andrews, K. D. Barnes, B.Sc., B. Ellis, M.Sc., A.N.C.R.T., M. D. Holdstock, A.R.I.C., D. C. Miles and H. L. Tulloch.

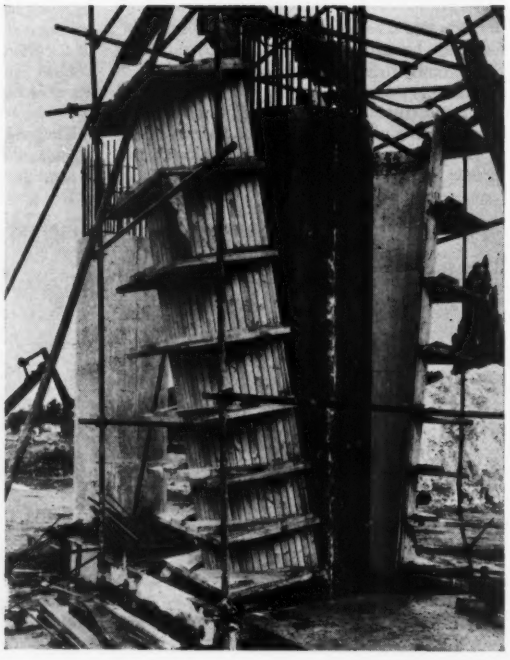
As Graduates; A. Hourd, B.Sc., B. Laxton, A.I.R.I., J. Pritchard, A.I.R.I., G. J. Spickernell, B.Sc., R. E. Trickett, B.Sc., and A. J. Wilson, B.Sc., A.I.R.I.

* * *

Polypropylene.—The Shell Chemical Co., Ltd., have recently announced that they are now able to offer limited quantities of polypropylene to the U.K. plastics industry for evaluation in the moulding field. So far beyond this statement no further information is available, although I believe that Carlona, its trade name, is not, as yet manufactured by Shell in this country. They have, however, suitable plant on the continent for its production so no doubt this is where it originates. But wherever it comes from the industry will welcome its arrival; much has already been said about the properties of polypropylene but few people have had the opportunity of assessing it for themselves.

PLASTIKON.

(Below) Open day at T. H. & J. Daniels Ltd. Visitors are watching the Reed-Prentice 10D Mark II injection machine in operation. This machine is manufactured by Daniels.



Polystyrene sheet liner used in constructing a concrete pillar on the Motorway.

Cellulose Propionate Part 1—Technical Aspects

By W. D. PAIST*

CELLULOSE propionate is the most recent cellulose ester to be produced in commercial quantities. This, the first of two articles on this new plastic, covers technical information while the second will describe its applications. In 1931, C. Dreyfus and G. Schneider of the Celanese Corporation of America, first made cellulose propionate (†) but it was not brought into full commercial production until 1955.

Cellulose is a long chain molecule having the graphical structure shown in Fig. 1. It is abundant in nature in the form of cotton fibres and as the structural element of wood. The cellulose used in the preparation of cellulose esters is either in the form of cotton linters (the very short fibres left next to the cotton seed after removal of the long fibres for textile use) or in the form of purified "chemical" pulp obtained from wood pulp after mechanically and chemically removing the lignin and other unwanted portions of the original tree. From Fig. 1 it will be noted that this long

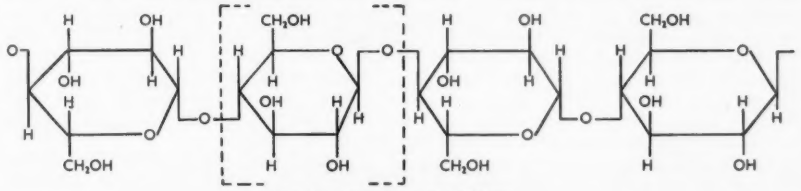


Fig. 1. Structure of cellulose.

chain molecule is built up of repeating glucosidic "units" as outlined by the dotted lines, which are joined together through oxygen bridges. Each unit has three hydroxyl (OH) groups available for esterification.

The most widely known cellulose ester, cellulose acetate, is used extensively in fibres and plastics. It is prepared by the reaction of acetic anhydride on cellulose in the presence of acetic acid and a catalyst. The "triester" thus formed is not so widely used in plastics largely because it is not soluble in cheap readily available solvents and plasticizers. By partially removing some of the ester groups and thereby restoring some of the original OH groups a more easily processed material having better solubility characteristics is obtained.

This "secondary" product is the acetate most generally found in plastics. Cellulose propionate is made in a manner similar to cellulose acetate, except that propionate anhydride is used instead of acetic anhydride Since propionic acid has three carbon atoms in its structure compared with only two for acetic acid, it has a larger molecule; and cellulose chains esterified with propionic acid are, therefore, kept further apart. This gives a material of lower melting point and wider solubility. Due to the chemical construction of propionate which results in a measure of "internal plasticity" less plasticizer is necessary to obtain an equivalent flow than is the case with cellulose acetate moulding compositions.

The combined effect of the above factors gives a product of very good dimensional stability, resistance to moisture, ease of moulding and of excellent toughness. The figures given in Table 1 illustrate these properties.

The widest use so far developed for cellulose propionate is in the preparation of Forticel moulding powders. Specially selected plasticizers having low volatility and good retention during ageing have been used during their preparation. The plasticizer is mixed with dry flake and fused or melted together on hot roll mills, in a Banbury mixer or in an extruder. The product is converted to a moulding powder and is then ready for moulding. If the moulding powder has been exposed to air for some time, it will require drying for about three hours at 180° F. The layers of material should not be deeper than 2 in. and the oven should be ventilated.

Best physical properties are usually obtained at the upper end of the moulding range. This range is 20° F. to 90° F. above the "cold point" (the temperature at which the mould just fills at normal pressures and cycles). The material temperature should not exceed 450° F. Mould temperatures should be in the 100° F. to 140° F. range depending on the hardness of flow of the material. The harder flows require higher mould and cylinder temperatures. Cellulose propionate can be moulded in relatively short cycles to give pieces of excellent surface finish. Cycles of 15 and 30 seconds are common. Round runners with restricted gates, of about 0.06 to 0.15 in. in diameter with lands of 0.02 to 0.07 in. (not pinpoint gates) are preferred. Mould shrinkage is between 0.002 and 0.005 in. per linear inch. Because of its excellent flow characteristics, well moulded parts can be obtained free from mechanical weaknesses and visual flaws. Several basic factors which should be considered in both part and mould design when one plans to use cellulose propionate are given here:

1. To facilitate ejection, maximum draft should be provided.
2. In respect to the parting surface of the mould, oblique or parallel cores require core pulling devices that should be designed so that no vacuum is created by their retraction, which could cause sink marks in the material.
3. Sharp corners, undercuts, and sudden changes in wall thickness should be avoided.
4. Wherever possible the mould parting line should be placed on a hidden part of the moulded item.
5. Ribs should support large flat areas, and can be used as runners. Ribs should never be more than 75% of the wall thickness.
6. External threads are easily moulded but internal threads usually require a threaded, removable core.
7. Metal inserts are best moulded-in.

Detailed Properties of Forticel

Toughness and Impact Strength

Forticel formulations are characterized by their toughness and flexural strength. Articles made from Forticel have a greater toughness than articles of equivalent hardness made from any other cellulosic ester. Even comparatively hard formulations of Forticel are quite tough. For a material having flexural strength in the range of 3,000 to 8,000 psi, its impact strength is extremely high. Forticel's combination of toughness and good flexural strength is unique among cellulose esters and is illustrated in Fig. 2. The curve is unusual, the impact strength rising very rapidly and giving high values in the region of flexural strength where it is very desirable. These high impact strengths occur at moderate plasticizer levels, where the other characteristics of the compound, such as dimensional stability and stiffness, are also at desired values. It should also be pointed out that the high strength shown by these Izod values has been confirmed by drop tests on a variety of injection-moulded pieces. Within the mouldable range, best toughness or impact strength is always obtained at highest moulding

TABLE I

Property	Test Method (ASTM)	Cellulose	Propionate
Plasticizer level—parts by wt. per hundred flake		10	20
Flow temperature, ° C.	D569–48	174	162
Equivalent moulding temperature, ° C.	—	207	171
Tensile strength, p.s.i.	D638–56T	4,900	3,500
Elongation, %	D638–56T	55	54
Impact strength, ft. lb./in.	D256–56	1.6	10.5
Flexural strength at break, p.s.i.	D790–49T	8,900	6,200
Hardness (Rockwell) "R" scale	D785–51	97	62
Water absorption, %	D570–54T	1.8	1.7
Leaching, %	D570–54T	0.0	0.1
Wt. loss on heating 72 hours at 82° C. (%)	D706–55T	0.9	1.0
Heat distortion temperature (264 p.s.i.), ° F.	D648–56	149	135

*Celanese Corporation of America.
†C. Dreyfus and G. Schneider, U.S. Pat. 1,824,877.

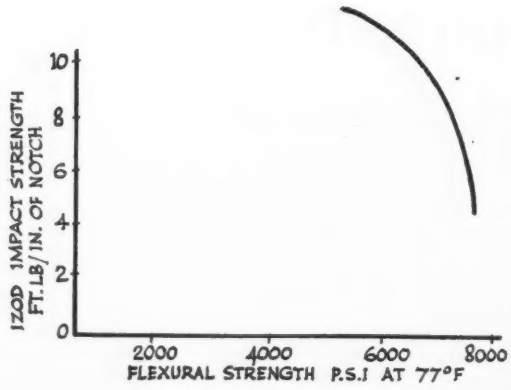


Fig. 2. Impact/Flex strength curve for Forticel.

temperature. In some cases, an increase in moulding temperature from 20° F. up to 60° F. above the " cold point " will double the impact strength.

DIMENSIONAL STABILITY AND MOISTURE SENSITIVITY

The low moisture sensitivity of cellulose propionate, predicted from its chemical structure, is borne out in practice and contributes to its excellent dimension stability. Forticel formulations have a water absorption between 1.6% and 2.0% (ASTM D-570). In most plastic applications, it is not the moisture absorption as such which matters, but the effect of moisture on the dimensions of the moulded piece. With a typical cellulose propionate formulation the increase in length in going from 0–90% relative humidity is 0.4%. No other cellulose ester plastic of similar general properties has less humidity expansion. From the low water absorption and humidity expansion of cellulose propionate, good stability against warpage can be predicted.

HARDNESS AND STIFFNESS

Cellulose propionate compositions are available in a variety of formulations ranging in surface hardness from —15 to +106 on the Rockwell R scale. They are, in general, somewhat softer than cellulose acetate and slightly harder than cellulose acetate butyrate of equivalent strength.

Detailed physical properties of a representative formulation series are given in Table 2 as measured on injection moulded specimens.

Electrical properties measured at 73° F. and 50% R.H. are given in Table 3.

Cellulose propionate is not compatible with cellulose acetate or ethyl cellulose nor with hydrocarbon polymers such as polystyrene, polythene, etc. It is, however, compatible with cellulose acetate butyrate and can be used in an injection moulding machine immediately following this material without machine cleanout.

SURFACE GLOSS

The finish obtained on pieces moulded in highly polished dies is extremely good, being superior in most cases to the finish obtained on other cellulosics. It is generally sufficiently lustrous and free of smudge for most parts to require no buffing. This high gloss is obtained over a wide range of machine temperatures and cycles. On the basis of this factor alone, substantial savings have been demonstrated.

ODOUR

Some Forticel formulations may have a faint odour when being moulded, but finished parts of cellulose propionate have no objectionable odour.

WEATHERING

Cellulose propionate has very good resistance to the degrading effects of sunlight, rain and snow, largely because of its low water-sensitivity. As is common practice with most plastics, light stabilizers are incorporated for best weather durability. Forticel formulations bearing the suffix code letter " LS " contain a light stabilizer. In any application which will be exposed to the elements, the " LS " formulation should be used.

The average useful life expectancy of a moulded cellulose propionate part when exposed to direct outside weathering depends on several factors.

Experience has show, as a result of studies started in 1947, that many light-stabilized pigmented compositions will withstand two to three years continuous outside weathering under severe conditions without any serious loss of physical properties, and under normal use would be expected to be serviceable after more than four years.

The following observations in Table 4 were made on cellulose propionate moulded specimens and give the solubility characteristics after 24 hours' submersion at room temperature:

TABLE 2

PROPERTIES OF FORTICEL

		Flow Temperature	Specific Gravity	Rockwell Hardness	Impact Strength (Izod)	Heat Distortion Temperature	Tensile Strength	Elongation	Flexural Strength	Water Absorption	Moulding Cold Point
Unit		°C.		R. Scale	ft. lb./in. notch	° C.	p.s.i.	%	p.s.i.	%	°F.
A.S.T.M. Test		D569–48	D792–50	D785–51	D256–54T	D648–45T (264 p.s.i.)	D638–52T	D638–52T	D790–49T	D570–54T	Relative
JM SERIES	A–(H2)	179	1.24	106	1.2	70	5,900	63	10,000	2.00	425
	B–(H2)	176	1.23	102	1.4	67	5,400	60	9,400	1.90	415
	A–(H)	174	1.22	97	1.6	65	4,900	55	8,900	1.80	405
	B–(H)	171	1.22	89	2.4	63	4,600	55	8,500	1.80	390
	A–(MH)	168	1.21	82	4.2	61	4,300	54	7,800	1.70	380
	B–(M)	165	1.20	70	8.5	59	3,900	54	6,600	1.70	360
	A–(MS)	162	1.20	62	10.5	57	3,500	54	6,200	1.70	340
	B–(MS)	159	1.19	53	10.8	56	3,300	53	5,800	1.70	325
	A–(S)	156	1.19	43	11	55	2,900	52	5,200	1.60	310
	B–(S)	153	1.19	33	11	53	2,600	51	4,500	1.60	295
	A–(S2)	150	1.19	21	11	52	2,400	50	4,000	1.60	280
	A–(S3)	145	1.18	—15	10	51	1,900	48	3,000	1.60	260

TABLE 3

ELECTRICAL PROPERTIES

Property	Test Method (ASTM)	Result
Dielectric Constant at 10^6 cycles	D–150–54T	3.0 to 3.5
Power Factor at 10^3 cycles	D–150–54T	0.010 to 0.011
Power Factor at 10^6 cycles	D–150–54T	0.017 to 0.020
Insulation Resistance (megohms)	D–257–54T	2×10^4
Dielectric Strength (volts/mil)	D–149–55T	600 to 1,500

TABLE 4

SOLUBILITY CHARACTERISTICS

	Soluble	Swollen
Acetone	Yes	—
Acetone/Benzene—25/75	Yes	—
Benzene room temperature	No	Yes
Benzene 80° C.	Yes	—
Butyl Acetate	Yes	—
Ethyl Acetate	Yes	—
Ethyl Alcohol	No	Yes
Ethylene Dichloride	Yes	—
Methyl Cellosolve	Yes	—
Tetrahydrofurane	Yes	—
Toluene	No	Yes

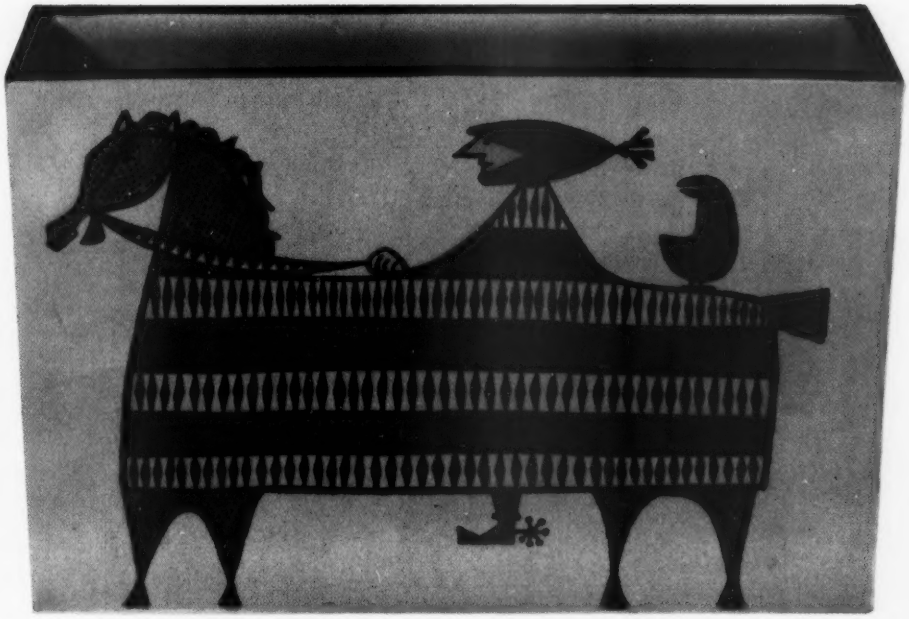
The following observations were made on Forticel test bars after 24 hours' submersion in the solvents listed below:

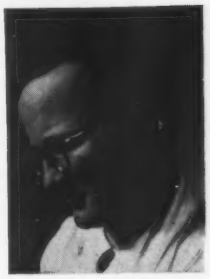
Wiping with the following cleaning solvents showed no effect:

1. Carbona (carbon Tetrachloride).
2. Turpentines.
3. " Pride " (Johnson's Cleaning and Waxing Compound).

(to be continued).

SWEDEN





Stig Lindberg, of A. B. Gustavsbergs Fabriker, is one of Sweden's foremost ceramics designer/craftsmen. His countrymen's lively colour sense and lack of colour prejudice is the theme of his message and is exemplified in the charming example of his work shown alongside.

the language of colour

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Stig Lindberg

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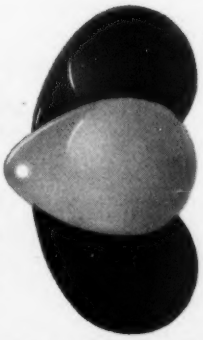

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Nottingham Conference on High Polymer Technology—Part 3

The proceedings are reported for "Plastics" by J. Glazer, Ph.D., and N. H. Langton,* M.Sc., Ph.D., A.Inst.P. This is the concluding article in this report.*

Graft Copolymer Formation during the Polymerization of Vinyl Acetate in the Presence of Polyvinyl Alcohol

F. D. Hartley, Imperial Chemical Industries Ltd., Dyestuffs Division, Hexagon House, Blackley, Manchester

This paper describes the technique used for the detection, isolation and identification of the graft copolymers which it was expected would be formed when vinyl acetate was emulsified in water in the presence of polyvinyl alcohol and an alkali, and polymerized with a water soluble persulphate catalyst. Preliminary turbidimetric observations had indicated the presence of graft copolymers, but the conventional methods of isolation had failed to give positive proof of their existence. The technique developed by the authors involves a chromatographic adsorption method.

The first portion of that part of the paper devoted to the descriptions of the experimental techniques is concerned with the preparation of the aqueous polyvinyl dispersions, followed by details of the turbidimetric experiments. Then there is a section on the use of paper chromatography for polymers, and then finally a detailed description of the method of continuous gradient elution chromatography used by the author in his investigations of graft copolymer formation.

In the section on results and discussion which ended the paper, the author states that his results show that paper chromatography can be regarded as a simple and reliable method for the detection of graft copolymers in the presence of the parent homopolymers. Work is described using three dispersions of the same quantity of vinyl acetate monomer and catalyst, but with different amounts of polyvinyl alcohol. Each dispersion gave rise to two different species of graft copolymer, one water soluble and the other insoluble. The relative amounts of the two species were found to differ in the three dispersions, as also did the molecular weight distributions of the polyvinyl acetate. A mechanism is suggested to explain these differences.

Graft Copolymerization by Pre-Irradiation Technique

D. Ballantine, A. Glines, G. Adler and D. J. Metz, Brookhaven National Laboratory, Upton, New York

The first part of this paper describes the method of producing graft polymers of polythene and styrene. Low and high density polythene film was irradiated by a cobalt^{60} source, and then contacted with the styrene, when grafting took place. Irradiation was done in both air and vacuum. A detailed description of the irradiation tube and the method of preparing the samples and adding the styrene is given. The amount of grafted styrene was determined by weighing. The effect of oxygen during the irradiation period is next considered.

In the discussion, the results are considered in the light of the formation of free and trapped radicals. The effects of the temperature of the grafting reaction are also discussed. For samples irradiated in air, it was found that the grafting rate increased with increasing temperature, whilst for vacuum irradiated samples, the converse was true, with an additional anomalous behaviour at —20° C. These observations are explained in terms of the mobility of the trapped radicals. The effect of crystallinity in the irradiated polythene is then considered. Experiments are described to test the hypothesis that the trapped radicals are most probably located in the crystalline regions where the mobility of the polymeric segments is low. The data given indicate that the immobile trapped free radicals produced by vacuum irradiation are principally located in these crystalline regions.

It is finally concluded that when polythene is irradiated, free radicals are produced. These radicals may occur in both the crystalline and amorphous regions. If in the former, they are immobilized and may survive for long periods of time and are potential sources of energy. If in the latter, they mutually destroy themselves or react with oxygen to form peroxides or hydroperoxides.

The Synthesis of Graft Copolymers from Polymers Previously Exposed to Ionizing Radiation. II. The Influence of Pre-Irradiation Conditions on the Kinetics of Polythene Grafting

A. Chapiro, Laboratoire de Chimie Physique, Paris

The ionizing radiations involved in this study were those from Co^{60}, X-rays and high energy electrons. Films of polythene were exposed to ionizing radiation, in the presence of air, and were then heated, under partial vacuum, in the presence of polymerizable monomer at 80° C. and 135° C. Surface hydroperoxidation occurred on the polythene surface, and these peroxidic groups, later acting as initiation centres, induced polymerization on the film surface. The rate of grafting reaction was found to be linearly related to the temperature of the pre-irradiation treatment. When a peroxidized film was heated *in vacuo*, it lost its capacity of initiation, thus showing that the active sites on the polymer surface were themselves thermolabile.

It was shown that the rate of grafting was diffusion controlled owing to the necessity for the monomer to penetrate the outer layer of the sample in order to react.

The Preparation of Graft Copolymers of Polytetrafluoroethylene, Radiochemically

A. Chapiro, Laboratoire de Chimie Physique, Paris

By submitting thin films of polytetrafluoroethylene to ionizing radiation (γ-rays from Co^{60}), as much as four times the original weight of the specimen could be added in the form of grafted polymer. The monomers investigated were styrene and methyl methacrylate. The kinetics of the system were described and it was concluded that diffusion processes were very important as rate determining variables.

The products, although low in p.t.f.e. content, retained some of the original properties in addition to some interesting, newly developed properties.

Molecular Weights and Molecular Distribution of Unbranched and Branched Polystyrene

G. Meyerhoff and M. Cantow, Mainz University

These authors described a comprehensive investigation that they had carried out in an attempt to relate the viscosity of a series of polystyrenes to their molecular weights. It was shown that these properties could be reasonably well related when attention was paid to, and allowances were made for, the degree of branching of the polymer. The inclusion of small amounts of divinyl benzene, during polymerization, gave products of varying branching and cross-linking, but this did not seem to affect the viscosity/M. Wt. relationship. On the other hand, the degree of conversion appeared to have important effects on this relationship.

Some Properties of Grafted Polymers in Solution

J. Danon, M. Jobard, M. Lautout, M. Magat, M. Michel and C. Wippler, Laboratoire de Chimie Physique, Paris

This paper described a series of experiments concerned with the factors making up the solubility properties of a series of graft polymers. For graft polymers made up of completely miscible polymers, the solubility coefficient was found to be the arithmetic mean of the component homopolymers. In the case of mutually immiscible polymers, it was impossible to ascribe any solubility coefficient.

Properties of Isotactic, Atactic, and Stereoblock Homopolymers, Random and Block Copolymers of α-Olefins

G. Natta, Institute Chimica Industriale del Poletecnico, Milan

This paper starts with a discussion of the problem of molecular weight regulation in the anionic co-ordinated polymerization processes, without change of the stereoisomeric composition, which the author considers to be important commercially.

The properties of vinyl polymers is very dependent upon their steroisomeric composition, and the next section of this paper deals with the influence of the polymerization conditions on the steric composition of the polymers in detail.

Then followed sections dealing with block copolymers, random copolymers and the physical properties of stereoblock polymers. There are numerous graphs and tables illustrating the points considered in the paper.

* Senior Lecturers, National College of Rubber Technology.

Concerning the Structure of Polythene Considered as a Mixture of n-paraffins

M. G. Gubler and A. J. Kovacs, Centre de Recherches sur les Macromolecules, Strasbourg

These authors presented the results of an investigation into the relationship between physical properties (specific volume), degree of crystallinity and chemical branching in a series of polythenes made by low and high pressure methods.

A simplified theoretical model was proposed to explain the observed results and good agreement was found.

Polymethylene and the Structure of Polythene: Study of Short-Chain Branching, its Nature and Effects

A. H. Willbourn, Research Department, Plastics Division, Imperial Chemical Industries Ltd., Welwyn Garden City

This paper is concerned with a new infra-red method which the author has developed for measuring the numbers and lengths of the branches in polythene. The first part of the paper consisted of a detailed discussion of the nature of short-chain branches in polythene, and some mention was made of the possible mechanism of formation. The remainder of the paper is a description of the experimental work and the results obtained.

For calibration of the equipment, samples of deuterated polymethylene were made. The number of branches in the polymer could be found by two independent methods, by direct determination of the deuterium, and by mass spectrographic analysis of the products of irradiation. These standard samples were then used to calibrate an infra-red spectrometer. A double beam type of instrument was used, and the main feature of the method is that a structureless unbranched linear polymethylene sample was placed in the compensating beam. In this way a calibration curve of the number of branches against the optical density at 1,378 cm.$^{-1}$ was obtained. The resulting calibration curve was linear. Results for other polymers are also given. Tables and graphs are shown in an attempt to correlate degree of branching of various polymers with other properties. There seems to be no correlation between degree of branching and density or degree of crystallinity.

The author concludes that there is very strong evidence that the short side chains which occur in ordinary low density polythene are mainly ethyl and butyl groups, and that the butyl groups predominate. The presence of ethyl groups is contrary to the predictions of the usually accepted theory of the formation of side chains, so that in the light of this paper a new theory of formation is required.

A Diffusion Theory of the Visco-elasticity of Rubbery Polymers in Finite Elastic Strain

M. Mooney, Research Centre, United States Rubber Co., Wayne, New Jersey

This paper is a mathematical investigation into the molecular theory of the mechanism of stress relaxation in a linear polymeric material. The molecules of the polymer are assumed to behave as a chain of sub-molecules, the lengths of which are distributed approximately Gaussian. The mechanism of relaxation is treated as one of diffusion in the phase space of the molecular configuration, applied to finite three-dimensional deformations. A solution of the diffusion equation is obtained, and expressions for the stresses in a deformed body are derived in terms of a strain-energy function. Particular applications of the theory are then discussed, together with the case of continuous shear, where expressions are given for the tangential and normal stresses for simple shearing at a finite rate. An attempt is made to explain non-Newtonian viscosity, and the case of a cross-linked polymer is considered, where it must be assumed that the positions of the cross-linked points are controlled by the sample of deformation only and cannot diffuse away from these positions.

Entanglement and Other Steric Effects in Cross-Linked Polymers

A. F. Blanchard and P. M. Wootton, Dunlop Research Centre, Birmingham

This paper describes experiments to determine the effects of trapped entanglements and other hindrances to the freedom of the molecular chains in highly cross-linked polymers. The simple modulus theory assumes that the chains are free at all points except at the cross-linkages. The effect of entanglements makes a modification of this theory necessary, and this is done by the authors, who assume that the effects of the trapped entanglements is equivalent to an additional number of cross-links. They show that the effect of these extra hindrances increases the modulus by a factor of $(1+\alpha)$, where α is the fractional number of entanglements per cross-link. A relationship between equilibrium swelling and modulus is then obtained, which is linear as in the simple case of no steric hindrances.

Experimental work on the swelling in toluene of three types of compound is then described. These results enable an assessment to be made upon the effects of steric hindrance upon modulus and swelling. By carrying out the measurements over a wide range of cross-linking a measure of the molecular flexibility can be obtained, and also an estimate of the solubility parameter for the polymer and solvent. It is concluded that for sulphur vulcanized polymers, the changes in the value of the solubility parameter make the swollen modulus a reliable method of measuring cross-linking.

Graft Copolymers from Natural Rubber Latex Using Visible, Ultra-Violet and γ-Ray Initiation

W. Cooper, G. Vaughan, S. Miller and M. Fielden, Dunlop Research Centre, Birmingham

This paper was concerned with the characterization of some of the kinetic and structural features of the radiation-induced polymerization of methyl methacrylate in natural rubber latex. The radiation used was γ- (Co^{60}) and photo- (U.V. and visible light), in the presence of a photosensitizer (e.g. 1 : chloroanthraquinone). Standard analytical techniques were used for measuring polymerization rate, and product molecular weight was characterized by intrinsic viscosity values.

It was shown that, in general, most of the polymer formed was graft polymer and its extent of formation was determined by extracting the product with acetone (to remove free polymethyl methacrylate) and submitting the remaining mixture of rubber and graft polymer to ozonolysis. Conversions were almost quantitative and, under suitable conditions, 100% of the PMM was grafted.

The authors showed that the M. Wt. of the grafted PMM units was approximately equal to that of the free PMM, but that the proportion of graft to free PMM decreased as the reaction progressed. They further showed that this proportion decreased with increasing monomer concentration for both γ- and photo-initiation. As expected, the polymerization rate was proportional to the square root of the intensity of the γ-radiation although this was not so for photo-initiation. This was probably due to the comparatively high opacity of the system towards the photo-rays. The reaction was found to be kinetically first order with respect to the monomer concentration, showing that the monomer was not involved in the initiation stage of the reaction.

The authors suggested that the observed falling off in grafting efficiency during the course of a polymerization was due to the preferential dissolution of monomer in the growing number of free PMM particles (rather than rubber particles), thus giving rise to an increasing estrangement between monomer and rubber during the reaction.

Ultra-Violet Induced Cross-Linking and Grafting of Solid High Polymers

G. Oster, Gisela K. Oster and H. Moroson, Polytechnic Institute of Brooklyn

The authors described some experimental results in which they showed that polythene could undergo cross-linking and grafting reaction under suitable conditions when irradiated by ultra-violet light (mainly 254 mμ) from a relatively inexpensive commercial lamp source. A photosensitizer was necessary for reaction to occur and benzoquinone was found to be eminently suitable. The polymer could be activated sufficiently by introducing the sensitizer during fabrication or by soaking the polymer in a solution of the sensitizer, before irradiation.

In this way, up to 60% of the polythene could be cross-linked after approximately 3 minutes of irradiation. A concentration of 0.3% of sensitizer in the polythene was found to be sufficient for this purpose. Strength determinations at 150° C. showed the superiority of cross-linked polymer over non-treated polymer. Even at room temperature, the tensile strength and elongation at break had been markedly increased by U.V.-induced cross-linking.

When a benzophenone-sensitized film of polythene was irradiated for one minute and subsequently heated at 70° C. with styrene for 1 hour, it underwent a 20% increase in weight. This increase in weight was shown to be due to a grafting reaction by the inability of benzene to leach it away. The final film had improved adhesive properties towards a pressure-sensitive tape and when the grafted group was hydrophilic (e.g. acrylamide), the product could be written upon with aqueous inks.

The Production of Graft Copolymers from Poly-α-Olefin Hydroperoxides

G. Natta, Instituto Chimica Industriale del Politecnico, Milan

The author related how he and his colleagues had been investigating the autoxidation, in the solid state, of some highly crystalline, isotactic polypropylenes. These workers had shown that peroxidation and hydroperoxidation occurred but was limited to the surface and intercrystalline amorphous regions of the polymer. Similar autoxidation could be performed by solution techniques at *ca* 80° C. when a more homogeneous reaction occurred.

These hydroperoxidized polymers were eminently suitable as chemical grafting supports and by immersing such polymers in suitable monomer solutions (e.g. methyl methacrylate at 70° C.), it was possible to coat

the polymer surface with a chemisorbed, thin film (0.01 mm. to 0.1 mm.) of hydrophilic polymer. In this way, dyeable surfaces could be obtained.

It was of interest that modified polystyrenes could be made by the solution grafting of styrene residues on to peroxidized atactic α-olefin polymers and that such products were of high impact strength and excellent ageing properties. When vinyl chloride was polymerized in the presence of hydroperoxidized α-olefin polymers, the resulting graft polymer possessed improved resilience and ultimate elongation with no concomitant fall in second order transition point.

The use of hydroperoxidized poly-α-olefins appeared to be of more immediate commercial interest than high energy radiation processes, although restricted at present to olefin polymers containing a number of tertiary carbon atoms which acted as hydroperoxidation sites along the polymer.

Mastication of Rubber. VIII. Preparation of Block Polymers by Mechanical Shear of Polymer-Monomer Systems

D. J. Angier, R. J. Ceresa and W. F. Watson, B.R.P.R.A., Welwyn Garden City

The results presented in this communication represented an extension of these workers' previous results which had shown that block polymers could be produced by masticating or extruding a rubbery polymer in the presence of a polymerizable monomer. The process was preferably performed in the absence of oxygen.

The authors now showed that conventionally hard thermoplasts (e.g. polystyrene, p.v.c., p.v.a., etc.) would undergo graft polymer formation after having been rendered rubbery either by thermal softening or by swelling in a suitable solvent. The separation of block polymer from homopolymer was achieved by fractional precipitation and the products obtained were characterized by viscosity, infra-red and standard analytical techniques. The ratio of monomer to polymer best suited to give high yields of block product was determined partly by the physical condition of the mixture, and it was mentioned that a typical polyvinyl acetate (M. Wt. 13,000) swollen by *ca* 10% of a monomer was too fluid to undergo chain scission by shearing forces, whereas an epoxy resin of comparatively low M. Wt. (<4,000) was sufficiently viscous to react under similar shearing conditions. As expected for chemical reactions based on a shearing mechanism, the rate of mastication polymerization possessed a negative temperature coefficient. This was due to the reduction of shearing forces as the temperature increased.

For the system styrene/methyl methacrylate, the magnitude of the viscosity parameter k^1 suggested that the block polymers were linear and consisted of comparatively few blocks each of fairly long length.

The Orientation of Polythene

R. S. Stein, Department of Chemistry, University of Massachusetts, Amherst, Massachusetts

A polymer with a low degree of crystallinity may be regarded, from the mechanical point of view, as a rubber cross-linked by the crystals. The Kuhn-Treloar formula describes well the orientation of the amorphous regions of such a polymer. As the degree of crystallinity increases, interaction between the crystallites becomes significant and their orientation becomes dependent upon the surrounding medium. It was the purpose of Professor Stein's paper to characterize experimentally this interaction and to determine its effect on the coexistant amorphous material.

The author begins by describing the determination of crystalline orientation changes during stretching, and discusses the results obtained by X-ray diffraction and infra-red dichroism methods. The material used was polythene (Marlex 50).

The variation of amorphous orientation during stretching is then discussed, firstly by the use of birefringence methods, and then by infra-red dichroism.

Finally, the orientation of the crystalline superstructure determined by form birefringence and light scattering is dealt with.

Morphological Structures in Synthetic High Polymers

R. Eppe, E. W. Fischer and H. A. Stuart, Institute of Physical Chemistry, University of Mainz, Mainz, D.B.R.

This paper discusses the morphological structures of polythene, polyamide and other crystalline high polymers. The authors first consider crystallization from concentrated solutions, and photographs illustrate the structural features of crystallized Marlex 50, polythene, nylon and other materials. The photographs include electron-micrograph surface replicas and electron diffraction patterns.

The next part of the paper is concerned with crystallization of the material in bulk, followed by a section dealing with crystallization from the glass-like state.

Finally there is a long discussion about orientated and lamellar structures.

Strain-induced Crystallization in Polyethylene Terephthalate

A. B. Thompson, Fibres Division, Imperial Chemical Industries Ltd., Harrogate, Yorkshire

The fact that a filament of amorphous polyethylene terephthalate can be stretched over a hot plate without crystallization taking place at low tension, or with crystallization at high tension, without variation of temperature and speed through the hot region, shows how important it is to develop a theory of crystallization under stress, and this is what the author has attempted.

The simplest possible assumptions are made, and a visco-elastic theory based upon Maxwell's equation is produced. There are two simple mechanisms which can be used to describe the stretching process. Firstly, the linear polymer chains slip past each other bodily, and secondly, there is a recoverable uncoiling of the polymer chains. By assuming that the total strain is the sum of the viscous and elastic strains, we arrive at the simplest theory for a viscous elastic material. To this simple theory is added a new feature corresponding to strain induced crystallization. This is done by assuming, as a first approximation, that the effect of crystallinity is to increase the viscosity only. A linear function was assumed to connect the strain and the viscosity at first, but it failed to give the correct results, so it was replaced by a square law relationship which was more successful.

The behaviour of this model is then analyzed, particular attention being paid to the stretching process between rollers. The predictions of the theory are compared with the experimental results obtained from a simple two-roller drawing machine. It is shown that the correspondence between the simple theoretical model and the experimental results is reasonably good. The ideas behind the theory seem to be supported by X-ray measurements of the drawn fibre.

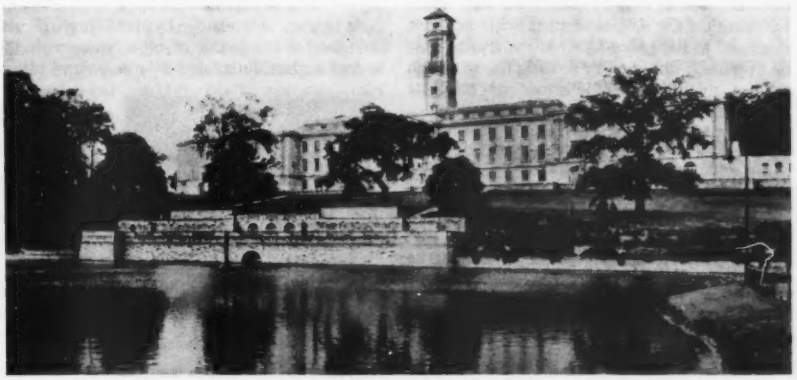
Other experiments using a tensometer are described and the results considered in the light of the theoretical model.

In his discussion, the author summarizes the extent of agreement between theory and experiment, and mentions ways in which the simple theory, which gives encouraging agreement, could be improved.

The Relation between Birefringence and Draw Ratio of Man-made Fibres

H. dé Vries, Central Laboratories, N. V. Onderzoekingsinstituut Research, A.K.U. and Affiliated Companies, Arnhem, The Netherlands.

This paper consists of an evaluation of birefringence measurements which can be used to test the validity of theories connecting birefringence with extension in the case of fibres. It is shown that there is a general empirical relationship which is " the slope of the birefringence natural extension ratio increases in proportion to the birefringence." The proportionality factor that occurs in this relationship is important, and the effects of varying its value are discussed in detail. It is of particular importance when this constant, denoted by p, is a small negative or positive multiple of $\frac{1}{2}$. Such values are called preferred values of p. There seems to be a tentative agreement between these preferred values of p and the chemical structure of the fibres considered.



Nottingham University, the location of the conference.

The Electron Microscopy of High Polymers—Part 2

By N. H. LANGTON,* Ph.D., A.M.Brit.I.R.E., A.Inst.P.
and MARGOT STEPHENS,* A.I.S.T., L. de Ph. (Lille)

Replica Technique

When it is required to observe the surfaces of materials, or when it is impossible to produce a thin enough slice of material to put into the microscope, a replica of the surface of the material must be made. This replica must be a faithful copy of the surface, and must be thin enough to allow the passage of electrons through it. One method of preparing a replica is to use the shadowing apparatus described previously. The procedure differs mainly in that the specimen is turned so that its plane is parallel to the surface of the window, W, so that it is normal to the direction of the metal particle beam. In this way a uniform film of metal is distributed over the surface. When this film is stripped off, the surface of it which was in contact with the specimen will be a mould of the specimen surface. The undulations of the specimen surface will, of course, be reversed on the replica surface. If this replica is placed on a specimen grid and viewed in the microscope, thick portions of the replica will absorb more electrons than thinner portions, and hence appear as darker regions in the field of view. Thus hollows on the original surface show up as dark patches in the picture on the screen. When this picture is photographed, these hollows will appear brighter on the negative, and darker again on the print.

The detailed technique for the preparation of replicas depends a great deal upon the type of surface being examined, and upon whether a positive or negative replica is required.

The negative replica is often referred to as a single stage replica, and is simply the shadow of metal thrown on to the specimen and then stripped off, as described above. Some care is needed in the interpretation of such replicas because of the reversal mentioned above. For this reason, positive replicas are sometimes to be preferred. Such replicas are known as two-stage replicas, and give a true picture of the specimen undulations. The method is simply to make another replica of the first one. The first replica may be of metal or plastic, and the second one of some material which will strip off the original replica without being damaged in the process. The first replica may be of plastic, obtained by coating the specimen with a thick layer of Formar or cellulose acetate, or even made by pressing warm thermoplastic material on to the specimen surface. This replica can then be shadowed by normally incident metal. If the first replica is made of gelatin, it can be removed from the second stage by floating the composite block in warm water. There is, however, some danger that the swelling of the gelatin may damage the metal film.

The production of replicas from rubber or plastic surfaces has several special problems. It is often difficult to remove the metal film, and attempts to remove the rubber or plastic by solvents may cause damage because of the swelling. If the first stage replica is not of metal, then it is best if it is prepared by using a water soluble substance which does not affect the specimen, and can be easily removed from the second stage metal replica. Figs. 10, 11 and 12 show some first stage replica photographs of the surfaces of Perspex before and after irradiation with X-rays or ultrasonics.

The Cutting and Examination of Thin Sections

A very important method of investigation is to observe the distribution of filler particles after they have been mixed into a rubber or plastic. To do this, it is necessary to cut very thin sections of the material. Such sections must be very thin, otherwise electron absorption will be too great for an image to be formed on the microscope screen. A specimen thickness of less than 0.1μ, that is 1,000 Å or 0.00001 cm., is satisfactory, the actual thickness depending upon the material and upon the amount of resolution required. If the specimen is too thick, electrons are scattered inside it and hence the resolution is impaired. In order to cut a specimen less than 0.1μ thick, a special microtome, called an ultra-microtome is needed. The normal biological microtome, using mechanical advancement of the specimen and a razor blade, will not cut below 1μ, partly because this method of moving the specimen forward is not satisfactory for movements of less than 1μ, and partly because a razor blade is too blunt.

The ultra-microtome uses a glass knife, which gives the sharpest edge it is possible to obtain easily. Fig. 13 shows a view of an ultra-microtome, made by Cooke and Perkins, with a close-up of the specimen and knife. The glass knife K is held in a holder H, which clamps it at the desired angle. The knife itself consists of a diamond shaped piece of plate glass, about ¼ in. thick and 3 in. long, the acute angle of the cutting corner being about 70 degrees. In the photographs, the knife itself is not visible, as the upper side is surrounded by a wax "boat." The knives are made by breaking off the diamond from pieces of plate glass with the aid of a glass cutter and a large pair of pliers. With a little practice, it is possible to tell whether a good edge has been obtained, by looking at it under the low power binocular microscope attached to the microtome at M. This method of producing knives is very cheap and simple, and although obtaining a good edge is to some extent a matter of luck, the ease of production has made this method most popular. The only other edge which is sharp enough is that obtained by sharpening a new safety razor blade. The edge of a normal unused safety razor blade is relatively blunt, but it is been shown that by means of a special sharpening technique a big improvement can be obtained. A considerable amount of skill is required, however, to perform this polishing operation, so that although the result may be better than a glass knife, the method is too difficult for general usage.

The specimen must be moved past the knife edge, and advanced by the correct amount after each cut. The specimen is held in an adjustable chuck, C, which is fastened to the end of a rod, the far end of which works in an unlubricated ball joint. A smooth forward specimen feed is obtained by thermal expansion. Part of the feed rod is heat insulated and provided with an electric heater, the current through which may be adjusted by a rheostat and monitored on a milliammeter. In this manner, an adjustable rate of feed is obtained, and the feed may, in theory, be as small as we desire, so that the thickness of the specimen depends only upon the sharpness of the knife. The chuck end of the feed rod moves in a guide so that the chuck follows a trapezoid path. This means that, on its return path, the specimen moves up to one side of the knife, so that the section which has just been cut is not wiped off the edge. The wax boat is filled with water, and as each slice is cut, it floats off on to the water surface and so is prevented from curling up. It is possible to see the sections coming off through the binocular microscope. The slices are removed, one by one, by fishing them out with a copper grid held in a pair of forceps, the grid being placed just underneath and then slowly raised. Once the specimen is on the grid, it will remain there, and can be allowed to dry and then stored in a gelatin capsule until required.

Fig. 10. Normal Perspex surface.

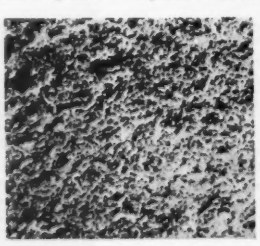


Fig. 11. The surface after 6 hrs. irradiation with X-rays.

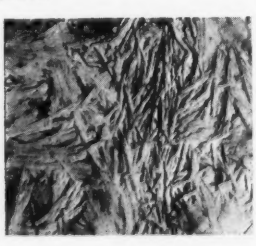


Fig. 12. After 2½ minutes ultrasonic irradiation

* National College of Rubber Technology

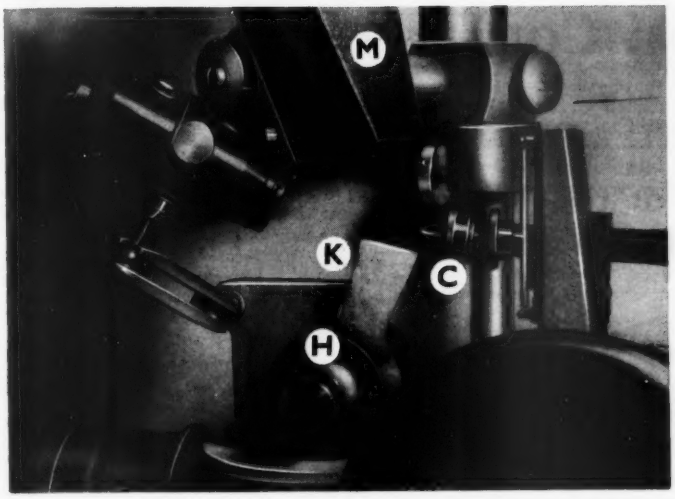


Fig. 13. Ultra-microtome showing chuck and knife.

Rigid materials can be cut immediately, but softer materials, such as rubber, tend to bend away from the edge of the knife as the chuck moves past. It is necessary to provide a supporting medium in these cases, so that the material is held rigidly round its sides. For the cutting of rubber, for example, a small piece about 1 mm. side length, and roughly cubical, is cut from the sample. This piece is dropped into the bottom of a gelatin capsule, Parke Davis, size 00. The capsule is then about two-thirds filled with destabilized monomer to which has been added some benzoyl peroxide. It is placed in an oven at about 60° C., and left for six, or more, hours to polymerize. The length of time it is left to polymerize depends upon the type of monomer used, and the hardness which is required of the final product. When the capsule is removed, a cylindrical block of polymer, containing the specimen at the rounded end, is obtained.

The surplus polymer is then removed. This is best done by clamping the lower end of the block in a Jacobs' chuck, and carving a small conical " table " at the upper end so as to expose a surface of the rubber. Once this has been done, the polymer block holding the rubber can be put in the chuck and adjusted for cutting.

In the case of rubber, the type of polymer used for embedding depends upon the hardness of the rubber. A soft rubber requires a hard polymer, as a general rule, although this is not always the case. Methyl methacrylate seems to be best for lightly loaded rubbers up to about 40 B.S. hardness degrees. For between 40 and 55 B.S. degrees hardness, isobutyl methacrylate is best, and for between 55 and about 65 B.S. degrees, n-butyl methacrylate is satisfactory. The polymerization time is also important, since this determines the degree of hardness of the block. The average polymerization time is about six hours at 60° C. with about 1% to 3% benzoyl peroxide as initiator. All rubbers below about 95 B.S. degrees hardness need embedding for satisfactory cutting.

On the other hand, a material should not be too hard. If this is the case, the material may just chip, crumble or break. Most plastic material will cut without much trouble, and does not, of course, need embedding. If the plastic is very heavily loaded, however, it may just crumble. It has been found impossible to slice polythene with 15 volume loading of calcium carbonate, for example, presumably because the polymer does not wet the filler. Bakelite is also difficult to cut, which is true for most thermo-setting materials. The angle at the corner of the glass knife is quite critical. For rubber, an angle of about 45° is best, whilst for harder materials, an angle of 60° or more is required. The optimum angle can only be found by experience, and depends upon the material being cut.

The amount of water in the wax boat is also rather critical. Too little water and the slices build up on the edge of the knife, whilst if there is too much, the slices are liable to be wiped off by the sample on the next cutting stroke. Sometimes the addition of a little wetting agent helps, but this may cause the slices to sink. If the material to be cut is soluble in water, ether or chloroform may be used, although this tends to make the wax boat leak. Some photographs of sections are shown in Figs. 14 and 15.

Photography

The photographic techniques used are normal, except that they are almost invariably directed towards increased contrast. An ultra-hard paper, such as Ilford Grade 5, should be used, and it is usual to under-expose and over-develop the prints. An ultra-fine grain developer is used with a fine grain film, to reduce the graininess of the negative to a minimum. If this is not done, on enlargement, the grain of the film may be taken as fine structure in the specimen.

Interpretation of Results

The interpretation of electronmicrographs of particles is generally straightforward, except for carbon black and acicular zinc oxide. These materials appear to collect electrons and some expansion takes place. The diameter of the spherical carbon black particles may increase under electron bombardment in the microscope.

If the particles are embedded in rubbers or plastics, some errors may be caused if the section which is cut is too thin. In this case here is the danger that the particles may be broken by the knife-edge, or rearranged by the cutting procedure. This danger should always be kept in mind when interpreting the results of sections, as it cannot be eliminated. Results from particle counts should always be subjected to a statistical analysis.

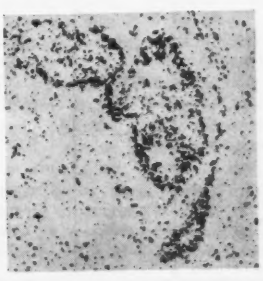
Another source of error in the interpretation is due to the thermal effects of the electron beam on the thin section, or upon the supporting film. Frequently a hole appears in the section or film, and shrinkage will occur, the hole growing bigger under the electron bombardment. As a rule such areas of shrinkage can be recognised because the crease marks in the section or film are parallel, and at right angles to the direction of shrink.

The interpretation of replicas is one of the most difficult tasks of the electron microscopist. Shrinkage of the replica may cause artifacts which can be easily confused with surface irregularities on the specimen. If there is any contamination of the surface of the specimen before shadowing, this will appear as a surface effect in the microscope. Distortion of the specimen as the replica is being removed cannot be recognized except by making several replicas by slightly different techniques and accepting the common factors as being real. Distortion may also be caused as the replica is being placed on the grid, and again, repeat observations are the only way to distinguish between artifacts and reality. The use of the double replica technique doubles the chance of misinterpretation, and for this reason should be avoided if possible.

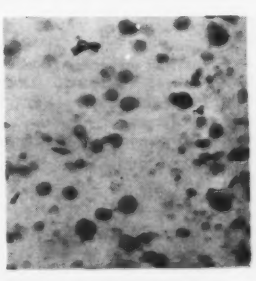
Conclusions

The use of the electron microscope in the investigation of problems concerned with high polymers is still to a large extent an unexplored field. Most of the work up to now has been mainly in the field of identification of particles, investigation of particle sizes and shapes, and, to a smaller extent, the study of surfaces. Very little has been published concerning the distribution of particles in the high polymer mixes themselves, mainly because of the difficulty of cutting sections. With the advent of the ultra-microtome, it is hoped that results in this field will soon be forthcoming. Investigations into the correlation between the physical properties of high polymers and the particle sizes, shapes and degree of dispersion of the fillers should lead to valuable conclusions.

(concluded)



(Left) Fig. 14. Section of rubber with dispersed colloidal ZnO, illustrating a bad dispersion.



(Right) Fig. 15. Section of rubber containing carbon black from extruded rod.

Federation Conference

The conclusion of the report and extracts from the papers presented at the British Plastics Federation Conference held recently at Torquay.

New Material Requirements of the British Plastics Industry Today and Tomorrow

By H. M. STANLEY

IN an industry such as the British Plastics Industry, in which the cost of raw materials and intermediates constitutes a substantial proportion of the total cost of the final products, the availability of raw materials at internationally competitive costs and in quantities adequate for present requirements and future expansion, is obviously a matter of prime importance. In this paper an attempt is made to review the raw material bases of our Plastics Industry, particularly from the viewpoint of competition from other producing countries, and to give some indication of the changes in raw material requirements which are likely to develop in the immediate future as a result of expansion and the introduction of new plastic materials.

For the purpose of this paper I am proposing to use the term "plastics" in its broadest sense to cover not only well-established thermoplastic and thermosetting substances, but also synthetic resins, fibre-forming materials and rubber-like materials, i.e. the whole range of synthetic polymer organic materials.

Present U.K. Production

The total output of thermosetting and thermoplastic materials (excluding fibres and rubbers) has grown from below 200,000 tons in 1950 to nearly 400,000 tons in 1957.

As far as can be ascertained, the production of individual plastics and fibre-forming materials in the United Kingdom over the last few years was as below (not inclusive of fillers).

As regards the production of synthetic rubber-like polymers, these have been small to date, but when the new Fawley plant of the International Synthetic Rubber Co. is in full operation, the production of rubbery butadiene copolymers in the U.K. should attain more than 70,000 tons per year.

Apart from the above productions, the Plastics Industry uses large amounts of auxiliary chemical materials as plasticizers, stabilizers, catalysts, etc. Of these, plasticizer esters (mainly phthalates) are particularly important, and probably amount to upwards of 30,000 tons per year at the moment.

Present Raw Material Basis

All industrial plastics materials as we know them today consist essentially of complex compounds of the element carbon combined with varying proportions of other elements. Since the basic skeletal structural material is carbon, plastics can justly be regarded as forming part (and a very large part) of the Organic Chemical Industry of the U.K.

COAL.—The first stage in the chemical utilization of coal is carbonization, either in coke ovens or in gas retorts. The major product of these operations is coke, but in addition large quantities of volatile and liquid products are formed, of which the most important as chemical intermediates are benzene, toluene, xylenes and naphthalene. Of these, benzene and naphthalene are essential in the manufacture of certain plastics.

Coke is the raw material for the production of calcium carbide and thence of acetylene, vinyl chloride, vinyl acetate and acrylonitrile. In addition, coke is used in the production of methanol and ammonia, from which respectively are formed formaldehyde and urea.

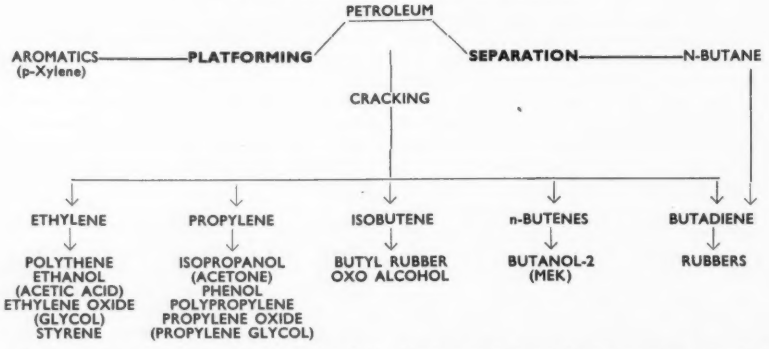
PETROLEUM.—Among the most important chemicals and intermediates being produced (or shortly to be produced) from petroleum are: ethanol, isopropanol (for acetone), ethylene oxide (and thence ethylene glycol), ethylene (for polythene), styrene, butadiene, Oxo higher alcohols.

The main method of conversion of petroleum into chemicals is to "crack" a selected fraction, usually a naphtha or a light gasoline fraction, whereby the carbon chains are broken and, from the fragments, a number of low molecular weight reactive (unsaturated) hydrocrabons are formed, including ethylene, propylene, butenes and butadiene. These unsaturated hydrocarbons are recovered in pure form and subsequently subjected to chemical reaction to yield the desired product.

Another method of using petroleum as a source of chemicals is to separate from it (usually by fractionation) a hydrocarbon of appropriate chemical structure and convert this directly (i.e. without cracking) into chemical products. This method, which though limited at the moment, is likely to become increasingly important in the future, is exemplified by the production of butadiene from n-butane.

Reference should be made to the growing importance as a chemical raw material of natural gas in countries like Italy, Rumania and France, where it is available in large quantities at low prices. It is particularly important as a raw material for making acetylene by a combustion-type process in an integrated plant in which the by-product gases are used in the formation of ammonia or methanol.

FIG. 1. PETROLEUM AS CHEMICAL RAW MATERIAL



ESTIMATED U.K. PRODUCTION OF PLASTICS AND FIBRES (TONS/ANNUM)

	1954	1955	1956	1957
THERMOSETTING MATERIALS				
Alkyds	34,000	36,000	40,000	44,000
Aminoplasts (moulding powder and resins)	36,000	39,000	41,000	42,000
Casein plastics	2,100	2,700	2,700	1,700
Epoxy resins			> 2,000	
Phenolics (moulding powder and resins)			42,000	44,000
Polyesters	400	900	2,200	3,200
THERMOPLASTIC MATERIALS				
Cellulosics	11,200	11,900	11,400	12,300
Polyacrylates and methacrylates		10,000	11,000	15,000
Polythene	20,000	30–35,000	45,000	55,000
Polystyrene	21,000	21,000	23,000	29,000
Polyvinyl acetate			11,000	12,000
Polyvinyl chloride and Copolymers	41,500	47,000	57,000	68,000
FIBRES				
Cellulose acetate	29,900	30,400	31,300	26,300
Nylon	10,300	13,800	15,600	—
Terylene	400	2,700	5,800	—
Others	2,300	1,800	1,300	—

The production from petroleum of some of the more important chemicals and intermediates for the plastics industry is shown diagrammatically in Fig. 1 above.

Present Raw Material Supply Position

From the information available on the production of individual plastics and allied materials, the above approximate figures have been calculated for the consumption of the various intermediate chemicals needed.

ESTIMATED APPROXIMATE CONSUMPTION OF INTERMEDIATES (U.K. 1957–58: TONS PER ANNUM)

Intermediate	Approx. quantity. Tons per annum	Used on production of	Basic raw materials
Phenol	16,000	Phenolics	Coal
Phenol Homologues	16,500		
Urea	25,000	Urea plastics and resins	Coal
Methanol (for formaldehyde)	30,000	Thermosetting resins	Coal
Phthalic anhydride ex 36,000 tons per annum	18,000	Alkyds	Coal
Naphthalene	12,000	Plasticizer esters for p.v.c.	Coal
Acetylene (Carbide equivalent 93,000 tons)	28,000	Vinyl acetate; vinyl chloride, acrylonitrile	Coal
Benzene	25,000	Styrene only	Coal
Ethylene	65,000	Styrene and polythene	Petroleum
Acetic acid and anhydride (as acetic acid)	38,000	Cellulose acetate fibre and plastics and vinyl acetate	Petroleum
Acetone	11,000	Methacrylates	Petroleum
Butadiene	60–65,000	GR-S and other copolymers	Petroleum n-butane
p-Xylene (for terephthalic acid)	8,000	Terylene	Petroleum

This table shows clearly that most of the intermediates needed for the production of thermosetting materials are ultimately derived from coal and its products of carbonization. On the other hand, the more rapidly expanding thermoplastic materials and synthetic rubbers are largely based on petroleum hydrocarbons.

As regards the present raw material situation, the position can be regarded as satisfactory in that the requisite raw materials are available in adequate quantities and at internationally competitive price levels. This is particularly so in the field of petrochemicals when the scale of manufacture in the U.K. is large enough to provide economical operation and the basic raw material is abundantly available at price levels which are reasonably stable and uniform over large areas of the world, and particularly Western Europe. In this connection it should be noted that the consumption of petroleum hydrocarbons in chemical manufacture is triflingly small compared with fuel uses.

Future Expansion

In spite of the uncertainty of predicting future production, certain trends, which are useful guides for the future, can be distinguished and these may be summarized as follows:

(*a*) The established thermosetting materials are likely to hold their place, but will probably undergo only a modest expansion over the next few years.

(*b*) Cellulosic plastics and fibres will probably remain relatively static, although some increase may occur in respect of the newer derivatives, e.g. triacetate fibre.

(*c*) The thermoplastic materials already firmly established, especially polythene and polyvinyl chloride polymers will grow very rapidly over the next few years. Polystyrene and its copolymers will also grow steadily, but at a somewhat lower rate.

(*d*) It seems a fair assumption that the next few years will witness the manufacture in the U.K. of a number of quite new thermoplastic materials (such as polypropylene, polyolefin copolymers) as well as of plastics which have already been commercialized elsewhere in the world, such as polyacrylonitrile for fibres.

(*e*) In the fibre field, nylon and Terylene will continue to grow steadily.

(*f*) The greatest potentialities for expansion would appear to reside in the field of synthetic rubber-like materials, the usage of which in the U.K. over the last few years is illustrated by the following figures:

ESTIMATED U.K. RUBBER CONSUMPTION (TONS PER ANNUM)

	1953	1954	1955	1956	1957
Natural	219,600	238,900	246,300	192,800	181,600
Synthetic	4,900	8,700	20,500	39,500	57,400
TOTAL	224,500	247,600	266,800	232,300	239,000
Individual Synthetics—					
S-type	900	1,900	9,300	26,500	42,600
Neoprene	2,300	2,800	3,800	4,100	4,800
Butyl	400	2,200	4,600	6,300	7,600
N-type	1,300	1,700	2,800	2,800	2,400

In assessing these figures it should be remembered that the usage of synthetic rubbers in the country has been limited by the fact that they have all had to be imported from hard currency areas.

On a world-wide basis, the total consumption of rubber and rubber-like materials is expected to increase by around 1,000,000 tons per annum in the period up to 1965. Since natural rubber production is unlikely to increase substantially in this period, it appears certain that a large increase in synthetic rubber production must take place in all the major industrial countries. In this country a good start has been made in the new Fawley factory of the International Synthetic Rubber Co. with a capacity of about 65,000 tons per annum of GR-S and the recent announcement of Du Pont's intention to produce Neoprene (estimated at 20,000 tons per annum) on the basis of acetylene in N. Ireland. Another important synthetic rubber is Butyl rubber, based essentially on isobutene, while other newer types, based on the polymerization of isoprene and of ethylene-propylene mixtures are under development abroad. The new German polyurethane rubbers based on propylene oxide polymers may also become important in this country.

On the basis of the above trends I think it likely that the production of thermoplastic materials (including rubbers and fibres) in the U.K. in the next five/seven years, say by 1965, will attain a figure of perhaps half a million tons per year, making a total production of both thermosetting and thermoplastic products of upwards of three-quarters of a million tons per annum. I visualize that the above figure for thermoplastics might include:—

(*a*) *Based essentially on petroleum hydrocarbons.*—Polyolefins and synthetic rubbers (excluding chloroprene rubbers) in quantities of several hundred thousand tons per annum.

(*b*) *Based primarily on acetylene.*—Vinyl chloride and vinyl acetate polymers and copolymers, as well as chloroprene rubbers and acrylonitrile fibre-forming polymers, the total material in this category being perhaps as high as 200,000 tons per annum.

(*c*) *Based primarily on aromatic hydrocarbons.*—Polystyrene, nylon and Terylene, the total quantity being probably of the order of 100,000 tons per annum.

As regards raw material availability, no difficulties are likely to arise in respect of the raw materials based on petroleum required in respect of category (*a*). The U.K. should be in a good competitive position in respect of these products in view of its large petrochemical industry and the fairly steady and uniform price level of the basic raw material.

The acetylene needed for the postulated increase in the production of these plastic materials enumerated in category (*b*) can, in principle at least, be simply supplied by increasing carbide capacity or by cracking suitable petroleum fractions. However, for reasons given later, it seems likely that much of these expansions will not be based on acetylene, at any rate in the U.K., but most probably on ethylene.

Difficulties are most likely to arise in the more distant future in regard to the supply of aromatic hydrocarbons, particularly benzene and naphthalene, which will be required in the contemplated expansion in category (*c*) materials, and in the provision of additional plasticizer esters, especially for p.v.c. The position in regard to these hydrocarbons is as follows:—

BENZENE.—The production of pure benzene from the most suitable raw material, namely coke oven benzole, has increased rapidly from 75,000 tons per annum in 1953 to 126,000 tons per annum in 1957. The ultimate capacity of U.K. coke ovens at present levels of steel production is somewhat difficult to assess, but is probably in the region of 180,000–200,000 tons with additional material perhaps 50,000 tons available from gas works benzole, though probably at higher purification

cost. I believe that the annual consumption of benzene in the plastics and associated industries by 1965 will increase by something like 50,000 tons per annum. This taken in conjunction with an appreciable increase in benzene usage for other chemical purposes (e.g. insecticides, detergents) will mean that supplies of home-produced benzene will tend to become inadequate, probably in the period 1965–70. Though in the long run we shall undoubtedly have to look to petroleum as a source of benzene to augment benzene supplies from coal carbonization, the economics of the production from petroleum are by no means clear at the moment.

NAPHTHALENE.—The production of white and hot pressed naphthalene has increased steadily from 26,000 tons per annum in 1953 to 33,000 tons per annum in 1956; in the latter year an additional 19,000 tons of crude naphthalene were produced. The increased consumption of naphthalene for the plastics industry (phthalic anhydride for plasticizer esters particularly) over the next five to seven years will probably be 10,000–15,000 tons per annum, a quantity which should present no great supply difficulty. The total potential production of naphthalene in the U.K. is probably of the order of 70,000 tons per annum.

Possible Changes in Raw Material Bases

It seems not improbable that important changes will, in the next few years, take place in respect of the raw material bases of a number of individual plastic materials, especially in the thermoplastic and fibre fields. The most notable example of this trend is likely to be in respect of acetylene. However, acetylene from carbide is a relatively expensive starting material, and unless much cheaper acetylene can be produced in other ways (e.g. from natural gas in Italy) great efforts will be made to develop new methods of production based on cheaper raw materials. Already substantial quantities of vinyl chloride are produced from ethylene in the U.S.A. and it can be anticipated that this tendency will spread to other countries. Again, vinyl acetate is being produced by a new process, discovered in this country, in which the raw materials are acetaldehyde and acetic anhydride, both of which may be regarded as derivatives of ethylene. In a recently announced new German method of making acrylonitrile, acetaldehyde replaces acetylene as the main raw material and this effectively puts acrylonitrile in the category of ethylene-based chemicals. This tendency to replace present raw materials by petroleum hydrocarbons, or the products of cracking of petroleum is illustrated by the recent announcement of the development in Russia of a nylon-like material (Nylon 7) which is based on ethylene rather than on benzene or phenol. As the use of petroleum hydrocarbons as chemical raw materials increases, we may expect competition as between one petroleum hydrocarbon and another. This is illustrated by the large scale production in the U.S.A. of acetic acid by the oxidation of n-butane, which thus competes with ethylene as basic raw material for this important acid.

Conclusion

The general conclusion appears inescapable that, with increased expansion in the thermoplastics and synthetic rubber fields, the industry will become more and more dependent on petroleum hydrocarbons as basic raw materials. Coal will continue to be the raw material for producing intermediates such as ammonia, urea, methanol and formaldehyde, as well as benzene and other aromatic hydrocarbons, but it will tend to be displaced for some of these productions by cheap natural gas in those fortunate countries where this exists.

It appears to me that a somewhat difficult supply position in respect of benzene from coal carbonization is likely to emerge perhaps towards the end of the next decade, and this will result in the development of methods for the production of benzene from petroleum.

In the much more distant future, when supplies of petroleum and natural gas are contracting in the world, there will inevitably be a return to coal as the main source of carbon for synthetic purposes, but this is unlikely to happen in the present century.

The Technical Future of the Plastics Industry

By H. A. COLLINSON

IN the title of this paper the word " technical " is really superfluous as the plastics industry has no past, present or future that is not technical. It is an industry founded on science and technology, and it is the efforts and expenditure in these fields that have produced the wide range of products which we call " plastics."

This year, 1958, is the 25th anniversary of the British Plastics Federation, and it is possible to look back to 1933, when the first chairman was Mr. Charles Waghorne, and to trace the progress made during the years between. In dealing with the future it is therefore proposed to look forward 25 years, to 1983, and in this paper attempt to give some idea of the development and progress that may be made through the next quarter of a century.

Looking Back

Before examining the future and the road ahead it is as well to note the road by which we have come. In 1933, 25 years ago, the total production of plastics materials in the United Kingdom was 20,000 tons; in 1957 the figure was 393,000, a multiplication of nearly 20 times in that period.

This present day production can be broken down into two broad groups—those materials which were being produced and sold on a commercial scale in 1933 and those which have reached maturity since that date. Twenty-five years ago the list of plastics materials offered for sale consisted mainly of: phenol, cresol and urea resins and moulding powders, cellulose acetate sheet, rod, tubes and film, celluloid, casein plastics and laminated material.

These materials represented nearly the whole of the 20,000 tons produced. In 1957 these same materials represented 180,000 tons of the 393,000 tons total, just under one half. This means that in 1957, 213,000 tons of plastics materials were produced and sold which did not exist commercially in 1933.

For simplicity it is proposed to refer to those materials commercially produced in 1933 as " old products " and to those developed during the past 25 years as " current products."

These current products are composed of: p.v.c., polystyrene, polyester resins, epoxide resins, vinyl acetate, acrylics, polyamides, p.t.f.e. and polythene.

As has been noted many times, the majority of these are thermoplastics, and indeed of the total production of some 223,000 tons of thermoplastic materials in 1957, only approximately 12,000 tons was in materials in existence in 1933.

Looking Forward

If the figures of the past 25 years are taken as a basis, a series of complex calculations can be made using the time trend or regression curve approach. These establish quite unequivocally and with mathematical accuracy that while the total plastics production in 1957 was 393,000 tons, the figure for 1970 would be 312,000 tons, a fall of 81,000 tons in 13 years. This may be explained as indicative of the fact that the industry is at present enjoying a phenomenal boom which will be followed by an equally phenomenal recession. Apart from being unpalatable, this forecast was considered to be somewhat unsound, particularly when it was determined that the time trend or regression curve had been developed for forecasting—albeit successfully—the progress of the ice-cream and hot dog industries where seasonal effects were most marked.

Growth Laws

From the U.S.A. there has recently appeared a number of Laws of Growth, one of which propounds: "As an economic factor, technology expands at an accelerating or sustained pace in contrast to biological phenomena which grow in their later stages at decelerating rates, and then become arrested on reaching maturity. The laws of biologic growth therefore differ from the laws of technologic growth."

The plastics industry is so closely locked with and dependent on technology that it would appear to be subject to this growth law. A sustained pace of expansion is usually taken as simple interest rate, and if this is applied to the total figure of plastics production, it predicts a doubling of output to 800,000 tons in 1983. This figure, while more progressive than that obtained from the regression curve, would hardly seem appropriate to our own vigorous industry.

An accelerated rate of growth would involve compound interest, and this would yield a total output of nine million tons in 1983. As the current production in the United States of America is 1¾ million tons this appears to be rather high. If, however, the compound interest rate is applied to what have been defined as " current " materials—that is, those developed since 1933—the production of this group alone in 1983 shows the phenomenal figure of 179 million tons.

It is clear from these exploratory figures that the future production must be somewhere between simple interest and compound interest growth rates and that the total figure itself cannot be used because of the diversity and complexity of the individual products grouped collectively under the single word " plastics."

To arrive at some estimate of the plastics industry and its products in 1983 some form of logical deduction must be used. It would seem reasonable therefore to break up the future production of this industry into three

component parts:

(*a*) " Old " materials covering those in commercial use in 1933.

(*b*) " Current " materials covering those in commercial use in 1957 but developed since 1933.

(*c*) " New " materials covering those in commercial use in 1983 but developed since 1957.

" Old " Materials

The " old " materials are now well established and have become part and parcel of our modern life. Over 25 years of scientific investigation and technical development lie behind them, and it seems unlikely that in the next quarter of a century there will be any startling new compounds within the field or any large increase in new applications. The increased demand will come largely from an increased per head consumption.

Some of this expansion may well be offset by the replacement with newer materials as, for example, the use of acrylics in telephones. History, however, rarely shows the total eclipse of a material.

Forecasts on future production of phenolics have always been underestimated, and while losing ground in some directions the inherent properties of the material usually assert themselves.

Taking all these factors into account it would be reasonable to forecast a sustained rate of growth at simple interest for the " old " materials, reaching a production figure of 360,000 tons in 1983.

" Current " Materials

" Current " materials have been defined as those that have entered the commercial production field during the last 25 years, and while from a volume angle they are mainly thermoplastic, there are some significant thermosetting products among them. As with the old materials a *per capita* increase due to the increased weight of plastics consumed per head of population will occur, and the packaging field is one of the striking examples of this.

By far the largest increase in demand for current materials will undoubtedly come from new applications, and as the full utilization of their unique properties develops so will the production demand rise. Technological and design progress will extend the use of these materials into fields as yet only just touched.

Mr. Collinson then continued by discussing the future of plastic materials in building where he foresaw an increase in its use for applications of a structural nature; in public transport; in furniture; in electronics and radio equipment and in horticulture. In all these fields Mr. Collinson prophesied a considerable expansion in the use of plastic materials, particularly for large structural units. He then commented on machinery and equipment as follows.

In considering new applications for " current " materials the importance of the machinery and equipment used in fabrication must not be ignored. It has been estimated that more than 20% of the fabricated plastics articles in the U.S.A. are extruded at some stage or other, and a thorough, scientific investigation into the theory of extrusion might well lead to a big increase in output.

Vacuum forming is another field for fundamental engineering research.

If all these new applications and techniques of fabricating are examined and considered together with the known expansion plans, which for polythene alone will increase the production capacity by 37,000 tons per annum, it is reasonable to assume that current materials will expand at an accelerating rate for at least two more years before settling to a sustained pace. Vinyl output is still rising and the acrylics have also shown an accelerating rate of expansion.

Taking all these factors into account a compound rate of increase has been assumed until 1960, followed by a sustained expansion at simple interest rates giving a production figure for current materials in 1983 of 1,094,000 tons.

" New " Materials

It has been noted that of the total production of plastics materials in the United Kingdom in 1958, over one half consisted of products which did not exist commercially in 1933. It is necessary, therefore, in considering the technical future of the industry, to assess what the likely tonnage will be in 1983 of materials not in commercial production in 1958.

Broadly speaking, there are three stages in the development of a new material—the discovery and isolation as an individual chemical, laboratory or pilot scale production, and full scale commercial production.

Many of the materials which have reached the production stage during the last 25 years are chemically quite old. Celluloid, melamine, p.v.c., vinylidene chloride, vinyl acetate and polystyrene were all discovered and isolated between 1840 and 1850. Silicone resins were also produced in the laboratory by Kipping about the same period and were discarded as sticky messes. They were not produced commercially until they were developed in the U.S.A. many years later.

If the dates for isolation, laboratory production and commercial production are studied, it appears that with one or two notable exceptions, such as polythene, the gap between isolation and commercial production has altered but little in the last 100 years; there has, however, been a considerable shortening of the time elapsing between laboratory production and commercial production. Cellulose acetate and phenolic resins were in the laboratory stage for around 30–40 years before they finally established themselves, whereas epoxide resins took three years, polythene five years, p.v.c. six years, and nylon six years.

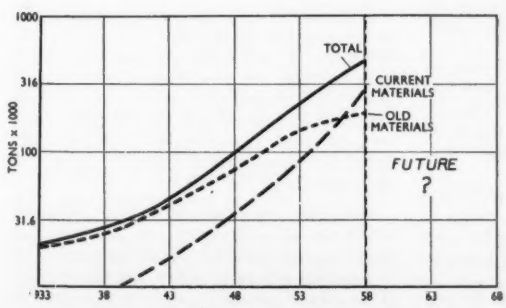
This marked trend to shorten the time between laboratory and full scale production is in line with the quickening tempo of industrial life and leads to the conclusion that many materials in the laboratories today will be in full scale production in three to four years' time.

Looking at the current laboratory activity it can be seen that polymer production and new methods of polymerizing dominate the scene and point the way ahead. Natta's isotactic approach makes possible such things as isotactic polystyrene with a melting point of 200° C.; and this type of break through technique opens new and interesting fields. Polypropylene is a reality with a higher temperature resistance than polythene and greater rigidity, and made from a raw material that is cheap and plentiful. Also in the experimental stage is a chlorinated polyether exhibiting physical characteristics in which no single property stands out over and above that of other plastics materials, but nevertheless giving a unique combination of properties, including good mouldability.

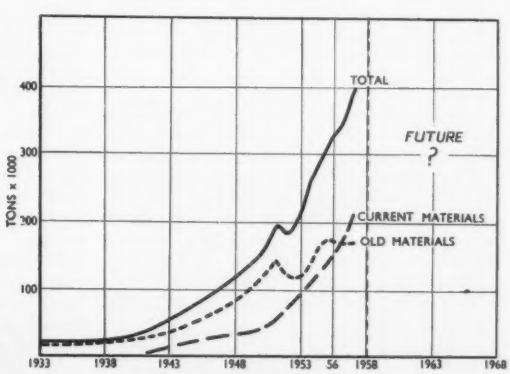
Polycarbonates with properties not widely different from epoxides and excellent for potting compositions may soon be available at prices below that of nylon. We have propylene polymers and ethylene polymers, why not polymers of ethylene oxide ? What can be done with naphthalene and pyridene derivatives; how can the unsaturated groups in allyl or vinyl cyclic forms be utilized ? It is possible to conceive polymers from carbon dioxide, and the inorganic field using boron and silicon should not be forgotten. Indeed, if one considers the implications of polymer chemistry, it is not unreasonable to feel that only the fringes have been touched.

All this activity in polymer building has led to the upsurge of the thermoplastic materials, but as the development proceeds there is a steady movement towards higher temperature resistance and greater application in the electrical field, and we may well see thermoplastic materials exhibiting the heat resistance and rigidity of the thermosetting plastics

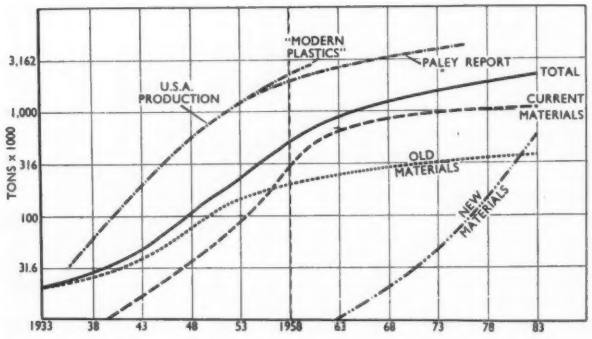
The importance of improved temperature resistance cannot be overestimated, particularly in this age of rocket and space travel; and in this connection the thermosetting materials, such as phenolics and epoxides, have quite. a good start Demand helps to provide the

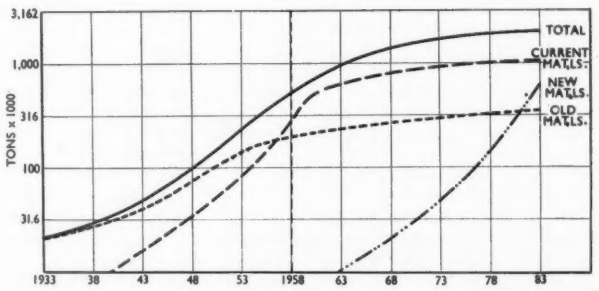


(Left) U.K. production (log scale showing general trend).



(Right) U.K. production of plastic material (actual).





(Above) Future U.K. production (log scale showing general trend). (Left) Comparison of U.K. and U.S.A. production (log scale showing general trend).

climate for technological advance, as for example the demand by the aircraft industry for greater heat resistance as higher speeds are attained; conversely, a cheaper product, such as polyformal, or one with outstanding advantages, can create the demand

In 1945, splitting the atom meant the production of bombs. Yet a few years later polymers were irradiated and shown to have changed their physical characteristics. Again it was thought that the limit had been reached, and that apart from small modifications in properties little use could be made of radio isotopes. Now there is a steady flow of information on radiation graft polymers and graft inter-polymers.

In this paper, only the fringe of the subject of new materials has been touched but it is sufficient to show that in 1983, as in 1958, there is likely to be a substantial tonnage of plastics materials in production that did not exist commercially 25 years before.

Taking into account the increasing speed of transition from laboratory to commercial production and assuming a growth rate in the next 25 years proportional to that obtained for "current materials," the production of new materials in 1983 can be assessed as 646,000 tons.

Summary

Using a process of logical deduction, coupled with a reasonable interpretation of the laws of growth, three figures have been obtained for the production of plastics materials in 1983:

Old materials	..	354,000 tons
Current materials	..	1,094,000 tons
New materials	..	646,000 tons
Total	.. ..	2,094,000 tons

To determine whether these figures are reasonable or wildly inaccurate, comparisons can be made with the position in other countries on the basis of consumption per head of population, and with other materials.

Other Countries

The present production in the United States is 1½ million tons per annum against the United Kingdom 393,000 tons. In 1956, the journal *Modern Plastics* prepared a "hunch estimate" forecasting a production in 1960 in the U.S.A. of 3,050,000 tons. The Paley report to the United States Government forecast plastics production in 1960 and 1975 at 2.15 million tons and 4.0 million tons respectively, a noticeably lower figure than that prepared by *Modern Plastics*.

The current ratio of U.S.A. to U.K. production is 4.5 : 1, and taking the *Modern Plastics* forecast for 1960 and that given here today for the U.K. in 1960 it is approximately the same at 4.4 : 1.

Per Capita Consumption

Assuming that the export markets have the same *per capita* consumption of plastics materials as the people of these islands, the present figures show 12.7 lbs. of plastics used per annum per head of population against an American consumption of 23 lbs. and in Germany of 21 lbs.

Taking into account the future increase in population, the U.S.A. figure for 1960 will be 39.5 lbs. per person; and on the basis of the figures given in this paper, the U.K. consumption *per capita* in the same year would be 22 lbs.

A production in this country in 1983 of just over 2 million tons would mean a *per capita* consumption of 61.5 lbs., and in considering this figure it should be remembered that in the four years between 1953 and 1957 the consumption per head in this country doubled itself.

Other Materials

Comparisons between plastics and other materials are both difficult and dangerous, but if not pushed too far they can provide a useful check. Would it be unreasonable to expect a production of plastics materials in 1983 approximately equivalent to the present total of non-ferrous metals, copper, zinc, lead, tin and aluminium ? In 1956 the consumption of these metals in the United Kingdom was 1,827,000 tons compared with a plastics production in 25 years' time of just over 2 million tons.

Conclusion

In this paper an attempt has been made to balance the concrete achievements with the hopes, to assess that which is almost in our grasp and also the more distant prospects, and to express them not only in general and technical terms of properties and possible applications but in terms of actual production tonnage and then to examine the figures to try to determine whether they are probable and reasonable.

The Publicity Requirements of the British Plastics Industry

By R. MACDONALD WATSON

OURS is an Industry which can claim to have set new standards in the speed and width of its development. From the time when there was only one plastics material—Xylonite—and that hardly recognized as the forerunner of a great new class of materials, up to this present conference, the tempo of expansion has accelerated. Gradually, at first, without much effect on other materials and then with increasing momentum which inevitably began to make itself felt in other industries.

While there was a great general increase in productivity the growing share of a wide range of markets which plastics products are claiming for their own, passed largely unchallenged but this could not be expected to continue indefinitely.

As long as there was plenty of business for everybody, the people interested in iron and steel, wood and china, leather and wool, paid little attention to plastics apart from an occasional reference to "synthetic substitutes."

We, ourselves, were too busy expanding and planning future production to look ahead to the rivalry which must come when we grow big enough to squeeze other people and tread on their feet.

The point I want to make here, as forcibly as I can, is that we are still very busy growing and planning but the other people have got beyond the point of noticing our existence; they are taking what steps they can to hold their own and may increase their efforts.

In this country today, the influence of clever propaganda is immeasurably greater than before the last war and I believe we should not close our eyes to the power of this weapon.

My objective in this paper is to persuade people in the industry to give serious thought to the desirability of a corporate effort to publicize the advantages and benefits accruing from the use of plastics and of products manufactured from plastics.

We question the wisdom of spending money on propaganda which may well benefit our competitor as well as ourselves and we chuckle happily when our rivals spend money from which we shall obviously benefit. Some simple logic will show us that, in certain fields, since we each benefit from the other's efforts, combined operations will be both cheaper and more effective.

Obviously, this argument applies to the case where we, as an Industry, are attempting to market to the public a comparatively new class of materials and the products made from them. If we sing in unison, or at least in harmony,

the noise will be louder and probably pleasanter to the ears of our hearers.

The British Plastics Federation has, as you know, a Press Officer, whose organization has done and is doing, much valuable work, some of the fruits of which can be seen on the notice boards in the Federation's meeting rooms. We also have a publicity committee composed partly of specialists in publicity from member companies.

What the industry lacks to enable it to make its mark in the minds of people at home and overseas, is a publicity policy and the funds to implement it.

Any policy which is based upon the needs of the industry as a whole, must take cognisance of two distinct but closely allied aims. One is the creation of confidence in the mind of the ultimate user of our products—call it educating the public, if you like; the other is the awakening of interest and appreciation in manufacturers outside the Industry, by whom the products could be used.

If we are to succeed on a scale compatible with the plans of the materials manufacturers for increased output, these two basic aims must be considered almost simultaneously.

Manufacturers who wish to avail themselves of the advantages offered by p.v.c. may reasonably expect support in marketing their products to the public, such as is given by the Leather Institute to users of leather. This takes the form of a vigorous and well-conceived advertising campaign, utilizing poster and national advertising on a considerable scale. In the same way, the Wool Secretariat and the Scottish Woollen Publicity Council seek to protect themselves from competition by synthetics. They use clever and well-produced propaganda in the Underground, in buses and in the press—that slogan "There is no substitute for wool," must have been worth a lot of sales to woollen goods makers! The Lead Development Association advertises the uses of lead by national press ads. and pamphlets. The English Joinery Manufacturers Association advertises the use of wood. The British Iron and Steel Federation boosts its products on a huge scale, and a growing number of other industries and groups within industries is daily putting publicity to work to advance corporate interests.

I submit that the plastics industry has ample opportunity and resources to pursue a similar policy of active propaganda and should lose no time in setting up the organization and providing funds to that end.

It is not within the scope of this paper to formulate a policy, but perhaps I may be permitted to advance a few ideas on the lines on which it might be devised, should the Members of the Federation agree that such a policy is desirable and worth paying for.

First, I would suggest a vigorous attack upon existing prejudices—without, of course, admitting their existence—by the presentation of very carefully planned statements of facts and figures relating to the growth of the industry and the part which it now plays in the economy of the nation.

A concerted drive of this kind for a period of three months or even less, could not fail to make an appreciable impression in this country and would have automatic repercussions abroad which could be fostered with little trouble and expense, throughout the European Common Market, at least.

Secondly, the publication of a series of pamphlets on a co-operative basis, publicizing the uses of plastics in the various fields of commerce and daily life, for example: "Plastics in the Home," "Plastics in Building," etc. Thirdly, the fuller and more extensive co-operation of members in efforts organized by the Federation to show plastics in the many exhibitions at home and overseas, wherein our foreign competitors show no lack of enthusiasm or enterprise.

Members of the B.P.F. constitute about 90% of the Industry, whose total production last year was reliably quoted at 393,000 tons, worth about 100 million pounds sterling. On those figures one fiftieth of a penny per lb. weight would produce £70,000 per annum. Obviously, we cannot seriously believe that we can't afford the few thousands necessary to make a good job of this.

Let's look at the facts about this.

We are a young industry and our stock-in-trade is largely new uses, new and better materials to do old jobs, and materials tailor-made to suit new jobs.

It is nearly all "new" and "young" when we speak of our business, and these very attributes, while they excite interest, also inspire doubt and even some suspicion, in conservative minds. Only two things can overcome this hidden resistance to the use of plastics by Industry and the public—time and convincing experience.

About the first, time, we can do nothing but wait. Fortunately, however, we are better placed in the other particular and we should use our advantage.

Finally, let me return to my exercise in simple logic. We are all engaged in the same endeavour; to produce and market plastics and things made from plastics, in preference to more conventional materials. The persuasion of people to buy and use these products can be best achieved and more economically achieved by corporate action.

To subscribe to a common effort in the same ratio, would appear to be a sound and logical business conclusion.

P.V.C. Life Jackets

KAPOK has been widely used during the past 30 or 35 years as a medium for filling many types of life jackets in view of its lightness and buoyancy effect. In more recent years however Kapok has suffered some criticism where it has lost its buoyancy effect due to the Kapok fibres becoming clogged with oil which is often present on the surface of the sea during life-saving operations. The oil menace has tended to increase due to a larger number of ships now using oil bunkers and also the greater number of oil tankers which are in operation today. The mechanism of this particular failure of Kapok is that each individual fibre consists of a tube which is sealed at each end by natural wax. This wax becomes softened by the action of oils thus allowing water to penetrate inside the fibre with a consequent loss of buoyancy.

In the middle of February, 1957, a report was issued by the Danes regarding the action of oils on Kapok, and they said that they would ban unprotected Kapok life jackets as from October 1, 1957.

The Ministry of Transport & Civil Aviation conducted trials, the result of these trials being that there was evidence of some risk of lost buoyancy when Kapok filled life jackets became contaminated by oil.

A committee was set up under the Chairmanship of Mr. E. C. V. Goad, head of the Marine Safety Division of the Ministry of Transport & Civil Aviation, in order to find out how Kapok filled life jackets could be made impermeable to oil. Members of this committee included representatives of the Chamber of Shipping of the United Kingdom, the Liverpool Steam Ship Owners Association, various seafarers' Associations and a number of life jacket manufacturers. The committee, after some detailed discussions and further experimental work by a sub-committee under Captain Hann, Principal Officer of the Ministry of Transport, felt that a p.v.c. liner or sachet fabricated by high frequency welding technique in which the Kapok was enclosed was the answer to this problem. Recommendations to this effect were made to the Ministry of Transport & Civil Aviation, and these recommendations were accepted in August, 1958.

During the period of time that the committee were sitting, Greenwich Plastics Ltd. of St. Mary Cray, Kent, were approached by the Ministry, and the problem affecting life jackets was discussed in full with their Technical Department. Four types of Craylene p.v.c. sheeting were prepared and tested under a series of identical conditions, and eventually one of these gained the official approval of the Ministry. The sheeting also complied entirely with all the requirements of British Standard Specification No. 1763. It was recommended by Greenwich Plastics Ltd. that the sheeting used for this application should be a laminated film, and it was suggested that this be in a thickness gauge .006 in./.006 in. (.012 in. over-all) and this was the finally selected type.

The position now is that a Statutory Instrument will shortly be laid before Parliament requiring that all "Standard" and "Victory" types of Kapok filled life jackets will be required to comply with the new regulations, the particular requirement being that the Kapok shall be contained in a p.v.c. envelope, of the type stated, to a specification laid down by the Ministry of Transport & Civil Aviation Committee. Life jackets with fillings that are affected by oil will be prohibited.

After a period of three months from the date when the Statutory Instrument becomes operative no new Kapok filled life jackets which do not comply with the Ministry rules will be approved. The rules allow a changeover period of one year for existing life jackets on oil tankers and two years for those on other ships. Ship owners will be asked to proceed as quickly as possible with the conversion of existing life jackets within the permitted changeover periods.

During the period of time when the Ministry were conducting their investigations, Greenwich Plastics Ltd. maintained the very closest liaison with them through the medium of their Technical Department, and the Company is one that has played an important part in the development of this improved type of life-saving equipment. The Ministry of Transport & Civil Aviation were kind enough to record their appreciation in a letter addressed to the Company in March this year.

Patent Review

The following abstracts have been made from specifications at the Patent Office, with the permission of the controller of H.M. Stationery Office. The country of origin for Convention Applications is shown in parentheses. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 3s. 6d. each (including postage).

B.P. 799,112. Manufacture of insulating layers, sheets or boards. To: A. G. der Gerresheimer Glashüttenwerke vorm. Ferd. Heye (Germany).

A foamable synthetic resin (polyvinyl chloride, polyvinyl acetate, polystyrol) and foaming agents are injected among the fibres in suspension in a stream of air or gas. The fibres are then deposited on a conveyor belt where the resin foams, e.g. by heating. The thickness is determined by a continuous pressing operation. The layers may be made with open or with closed pores.

B.P. 799,114. Plastic dies, jigs and the like. S. O. Jones. To: Pressed Steel Co., Ltd.

A tubular framework (for glass fibre reinforced plastic devices) with ball type joints so that the members of the frame may be assembled by swivelling on the ball. They are afterwards fixed by bonding with a synthetic cement.

B.P. 799,169. Manufacture of bottles from thermoplastic material. S. Dubiner (Israel).

Each cycle of operations includes the formation of two bottles in two different stages using three cores. While the moulds are closed a fresh slug is formed on a first core in an injection mould, while a previously formed slug is blown in a blow mould. While the moulds are open the first core is transferred to the blow mould, the second core from the blow mould to the outside station, the third core from the outside station to the injection mould. This sequence of operations takes into consideration that bottle necks need more time to cool and solidify than the bottle body.

B.P. 799,175. Mats or gratings especially for use in bathrooms. To: Barclay Stuart (Electronics) Ltd. (Denmark).

Built up from units of resilient plastics having ribs which are partly longitudinally curved partly straight. The units are assembled and connected to form mats by means of headed pins engaging slots with a snap action.

B.P. 799,284. Device for opening sachets made of a thermoplastic material. To: Centre National de Transfusion Sanguine (France).

Packages of the flat type made of flattened polythene tubing cut-off and welded transversely are difficult to open without scissors. A strip of material is therefore incorporated along the weld where the strip is penetrated by the thermoplastic during fusion. One end of the strip is folded off so as to project outside from the weld at right angles as a tear tongue.

B.P. 799,309. Dispensing stoppers for liquid containers. G. F. J. Dandridge, Needs Ltd.

Of two rotatable parts of moulded plastics, one of which has a taper to be forced into the outlet of the container, the other part forming the nozzle rotatable between stops on the first part.

B.P. 799,368. Made-up neckties. J. A. Armstrong (Australia).

With two tubes of polyvinyl chloride sleeved on a length of elastic cord fixing the tie.

B.P. 799,386. Extrudable polythene. To: General Electric Co. (U.S.A.).

Polythene, a filler, and 1% to 10% of a curable organopolysiloxane, based on the weight of filled polythene.

B.P. 799,392. High molecular polythenes. K. Ziegler (Germany).

Use of a catalyst formed by mixing an aluminium trialkyl and a compound of a metal of the "a" sub-groups of Groups IV to VI of the Periodic Table, including thorium and uranium.

B.P. 799,418. Dust caps for cycle pedals. H. van de Loo, O. Dreiser (Union Sils, van de Loo & Co.).

With reflectors embedded in a carrier in apertures of the cap.

B.P. 799,441. Lamp shades. A. Gluck, N. Gluck.

A pleated body divided transversely to the direction of the pleats by a flexible hinge into two portions each to be formed into a conical or part-conical shape.

B.P. 799,468. Spray nozzles. To: Risdon Mfg. Co. (U.S.A.).

For atomization of fluids at very low pressures (cosmetics, medicaments) from inexpensive containers to be discarded after use. With a polythene body forming a socket with a rigid orifice plate or cup forced into it.

B.P. 799,472. Protective shields for cycles. To Société d' Appareils de Contrôle et d'Equipment des Moteurs S.A.C.E.M. (France).

Fixed between a transverse upper frame part below the handle bar and a similar lower frame part at the level of the front wheel under tension.

B.P. 799,544. Synthetic plastic material. S. F. Deakin. To: Siemens Edison Swan Ltd.

Uniform thickness of a hollow polytetrafluoroethylene article by placing the material in dry loose form between a hollow flexible core and a rigid outer mould. The core is then expanded to compress the polytetrafluoroethylene followed by a heat treatment to set the preformed shape.

B.P. 799,547. Electrically heated flexible hoses. A. G. Heron.

An inner wire helix and an outer wire helix electrically connected at one end, the other end being connected to a low voltage source. The inner helix is embedded partially in the surface of the bore, the outer helix in the inner surface of an outer covering. As a hose for the disposal of defrosted water from refrigerators.

B.P. 799,613. Novel monolithic cast objects and method of preparing the same. A. H. Russell (U.S.A.).

A mixture of a liquid thermo-setting resinous composition with at least 50% (weight) of sand as filler is polymerized. Preferable are resins of the polyester type or an "epon" type (condensation polymers of epichlorohydrin and bisphenol-A) and a cross-linking solvent which does not volatilize when the resin is cured in the mould. For laundry tubs, wall tiles, road markers, table tops, sign-board letters, etc.

B.P. 799,628. Container for clothes pegs. F. A. J. Kup-Ferroth. To: T. T. C. Garratt.

Of basket like form with an open top. The rigid end pieces have hook shaped projections to hang the container on, and slide it along, the clothes line. The body part is flexible to be wrapped around the separate endpieces. The parts are sold in a flat package.

B.P. 799,631. Inflatable swimming aids and bathing devices. A. I. Shinberg.

A pair of inflatable tubes are held together by an apron of polyvinyl chloride or polythene giving support to the body.

B.P. 799,643. Containers. J. Brouwer. To: Unilever Ltd.

Made of two bodies (of polyvinyl chloride or polystyrene sheeting) one of which is hollow. Portions of the bodies are sealed together to form a flange with a filling opening to be sealed afterwards.

B.P. 799,672. Injection moulding apparatus. Projectile & Eng. Co., Ltd. M. G. Munns.

The machine is of the type having a transfer chamber between a main plasticizing chamber and an injection nozzle. Injection takes place by relative movement between an injection ram and transfer chamber. The peripheral surface of the ram is kept concentric (by spline-like projections) with the bore in the chamber and clearance between ram and bore permits flow of products past the ram out of the rear of the chamber.

B.P. 799,774. Vehicle instrument boards or dashboards. To: Daimler-Benz A.G. (Germany).

One of the superposed padded protuberances serves as a handhold. Underneath is inserted a translucent or transparent plastic strip illuminated from the rear and dispersing transmitted light. The strip may contain a radioactive substance energized by daylight and glowing in the dark.

B.P. 799,799. Animated whistle. J. H. Bacon (U.S.A.).

A (bird-shaped) whistle with moving wings and rolling eyes.

B.P. 799,841. Closure and /or holding device for bags of polythene and like film material. A. H. Minnaar (South Africa).

A disc and a cup-shaped member with a groove inside adjacent to its rim, both parts made of polythene. The disc is placed inside the bag and snapped into the groove of the cup outside. A cord may be drawn through apertures in the cup.

B.P. 799,862. Thermoplastic sheet material. To: Rotaflex (Gt. Britain) Ltd. (U.S.A.).

A sheet having the two surface layers interconnected by transverse webs leaving a series of parallel cavities between the webs is made by spiral-winding a filament (hollow or of certain cross section) on to a cylindrical core to be united into a shell with one continuous helical cavity. The shell is axially split, removed from the core, and flattened. The sheet produced is strong and stiff, has insulating properties, is flexible and resilient and of small specific weight.

B.P. 799,866 Display device To: Benbow & Co. (Modern Shopfitters), Ltd. D. R. Benbow.

A tray and a transparent cover with a mechanism to withdraw the tray only.

B.P. 799,872. Apparatus for applying plastic coating to wire. M. C. Cheney, C. I. McCall. To: Lewis Engineering Co.

For applying a coating of polytetrafluoroethylene using a die of rollers between which the coated wire passes into a sintering bath (fused nitrite and nitrate salt solution).

B.P. 799,886. Tobacco pipes, cigarette holders and the like. G. Defries.

A ring-like rotatable element on the stem with an inclined slot to vary the size of a transverse hole under the slot in the stem (for more economical use of tobacco).

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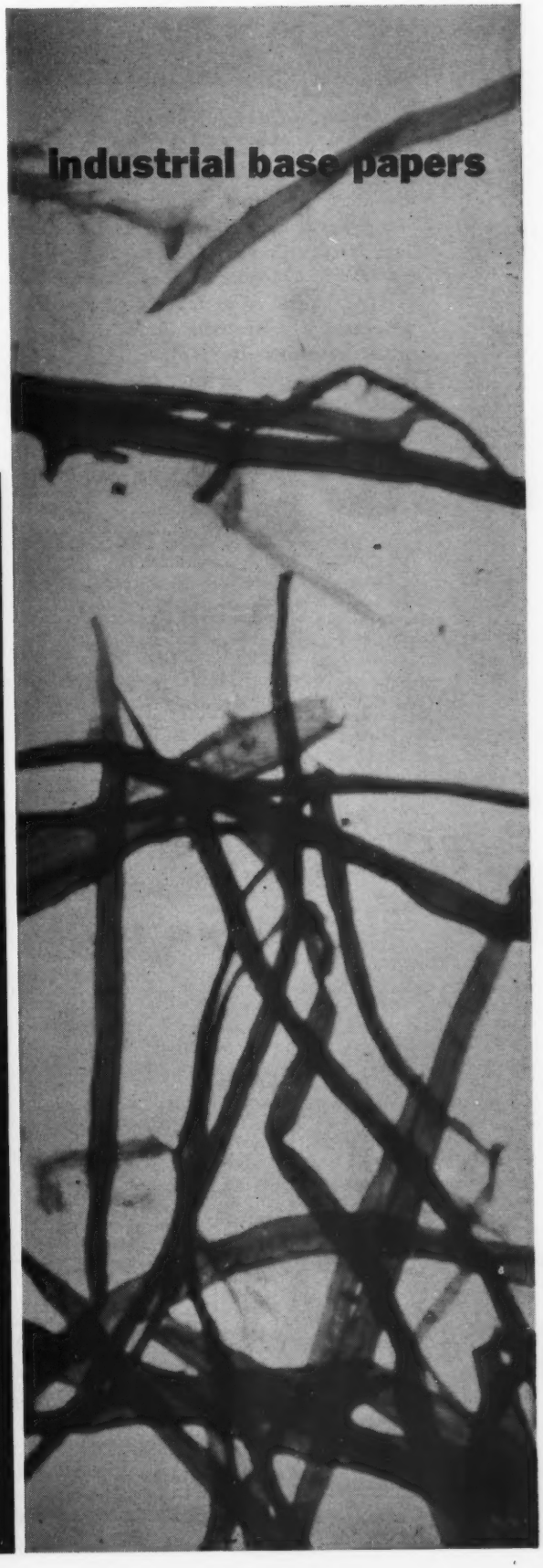
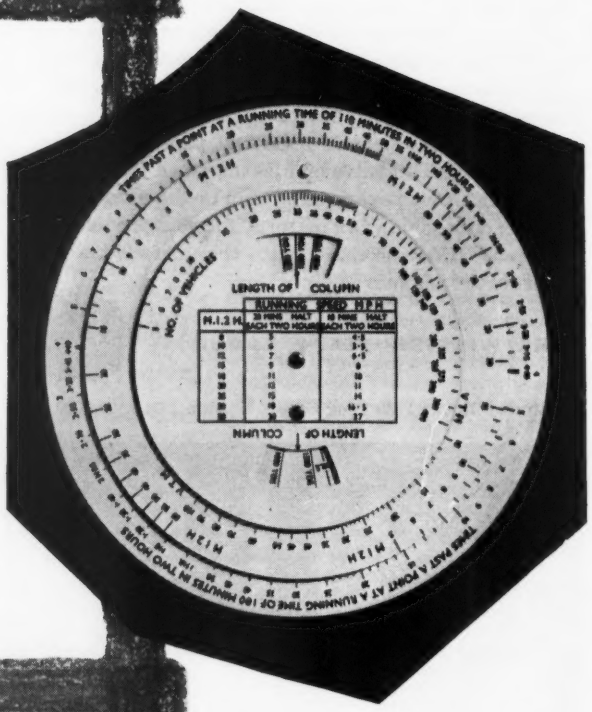


We calculate...

that nearly every trade needs printed plastics of one sort or another, whether they take the form of calculators, the one shown here, or any of our numerous different products in **printed, engraved or fabricated plastics.** We can make anything from sliding or circular calculators to adjustable price tickets or calendar cards—in any shape, any size, any number of colours. The time is sure to come when you need printed plastics; when it does, you can't do better than contact:



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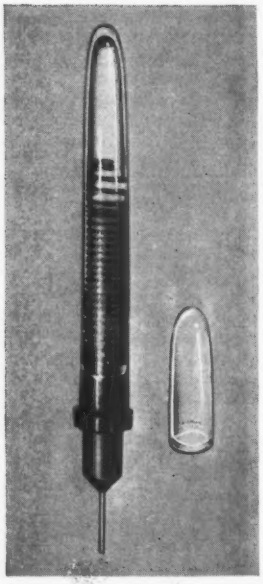
The case of the transparent oil-pen



Poppet oil-pen moulded in 'Tenite' Butyrate for Guardhook Ltd., London, S.W.10.

The problem, my dear Watson, is to find the nature of the material the Guardhook people used for their Poppet oil-pen. You will have remarked that it is an injection moulded plastics material of excellent appearance. You will further observe that though it is lightweight and transparent it is tough and dimensionally stable. It is clearly oil-resistant and tests will show that it has low flammability. Elementary, my dear Watson. It is obviously 'Tenite' Butyrate.

Here, as in many other cases, 'Tenite' Butyrate thermoplastics have proved that they are hard to beat for injection moulding or extrusion. Perhaps they can solve your moulding problems too.

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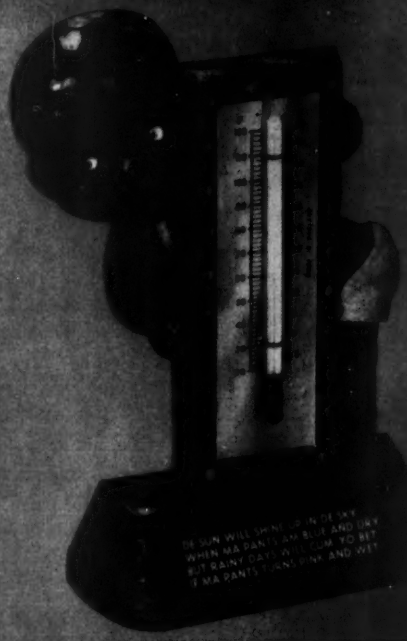

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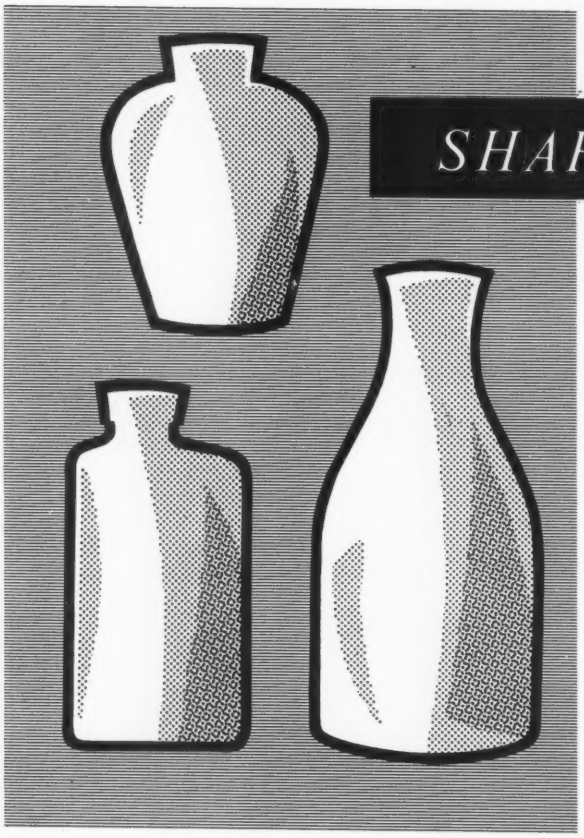

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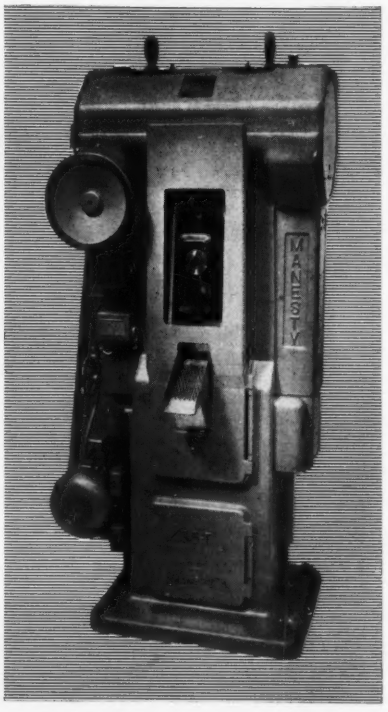

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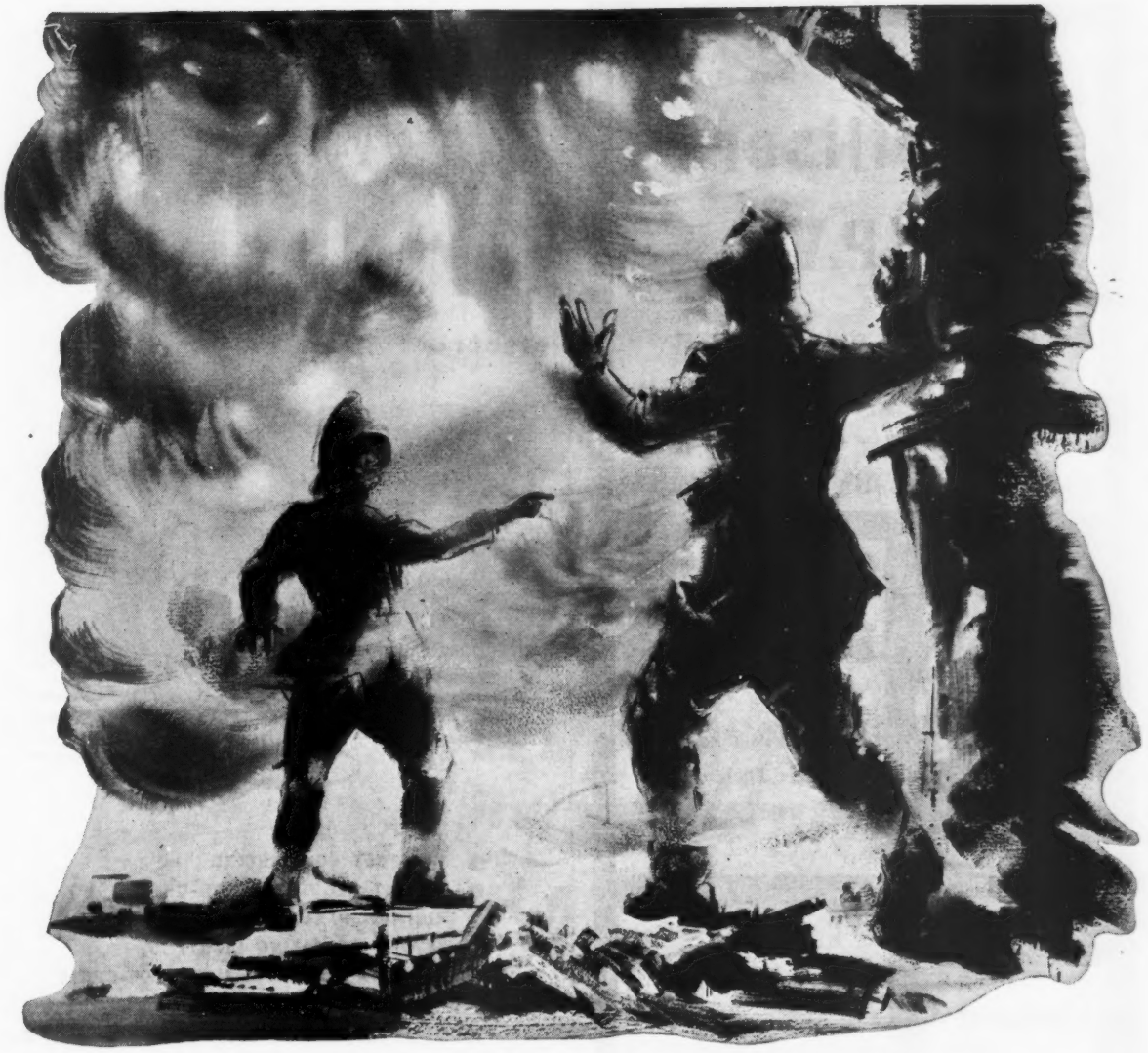

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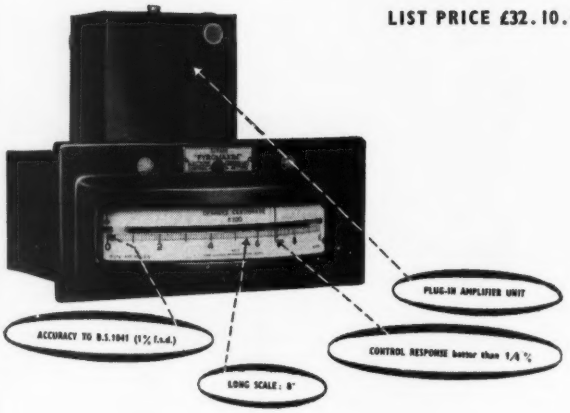

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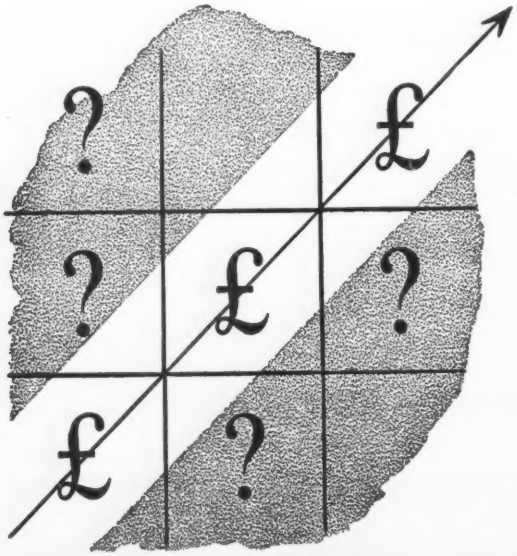

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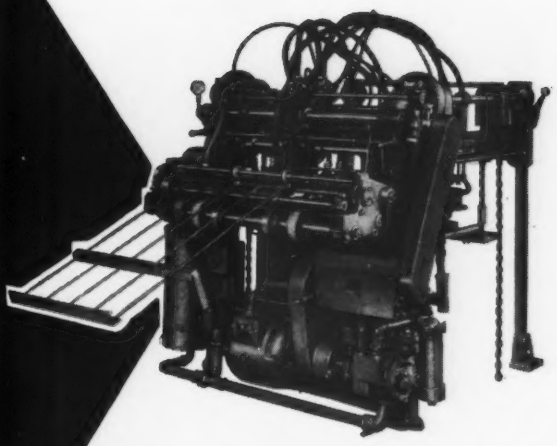

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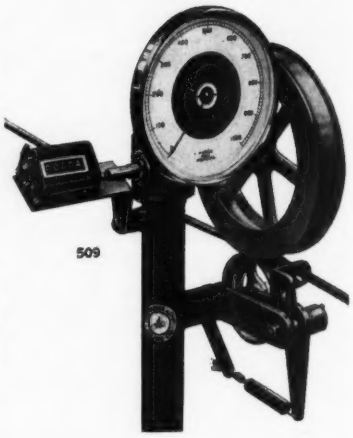

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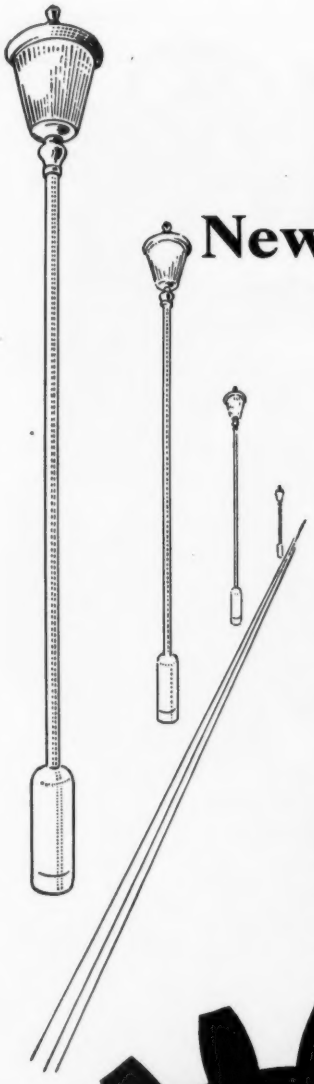

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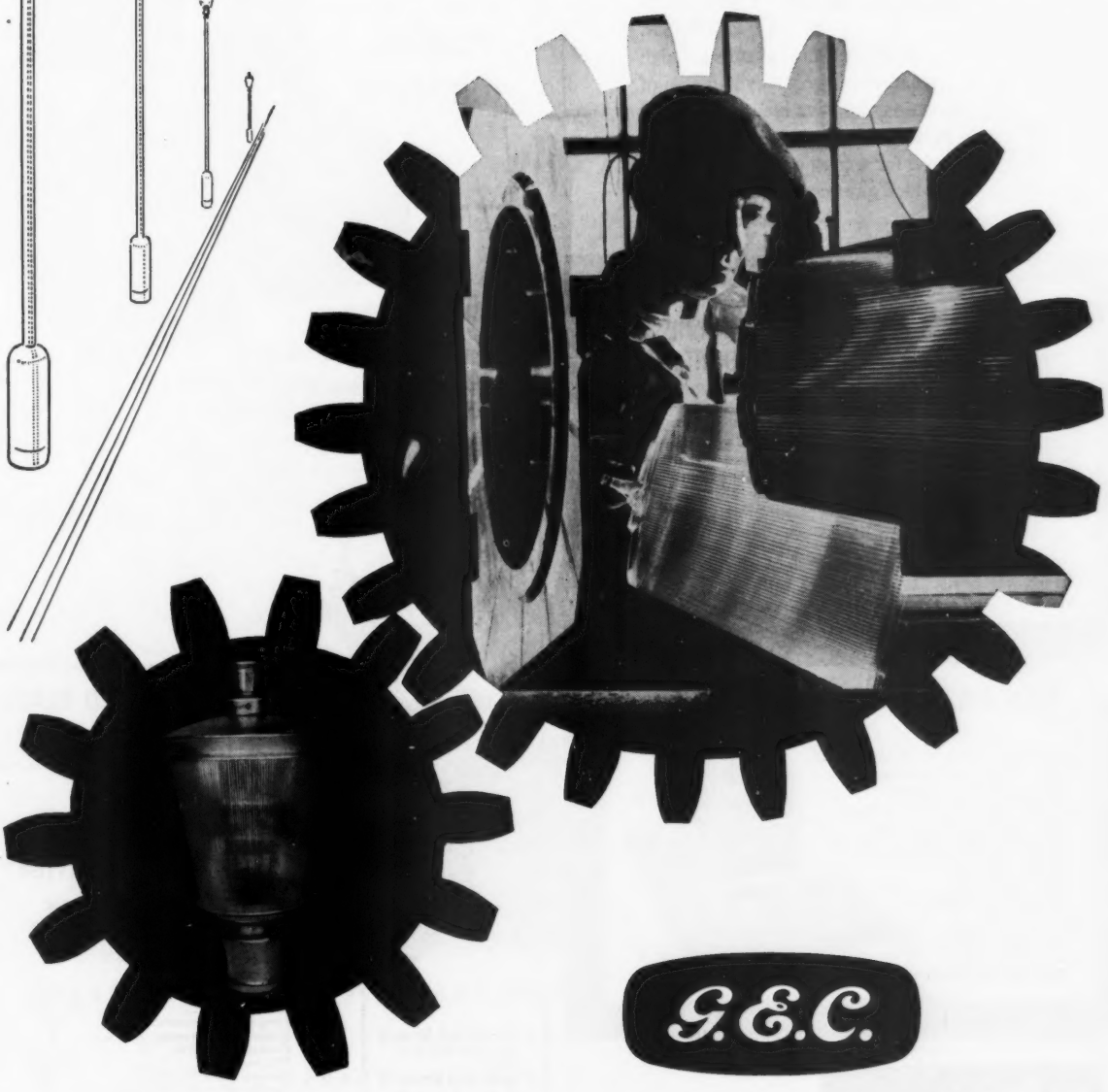

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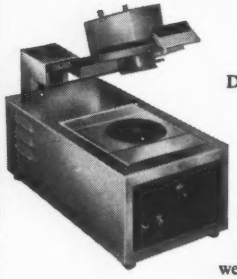

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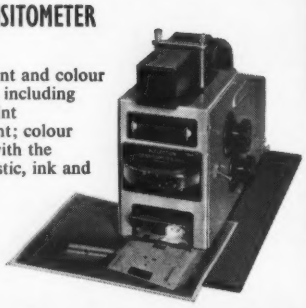

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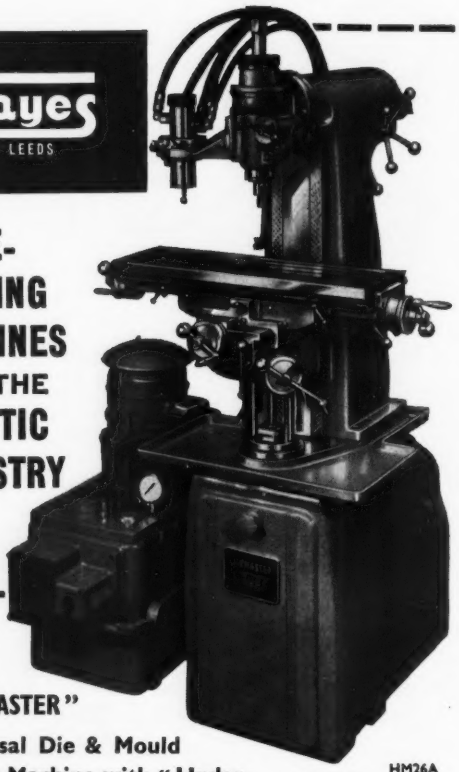

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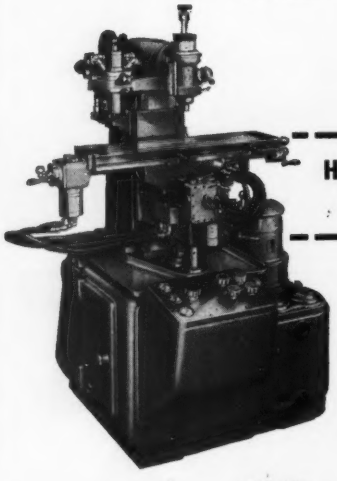

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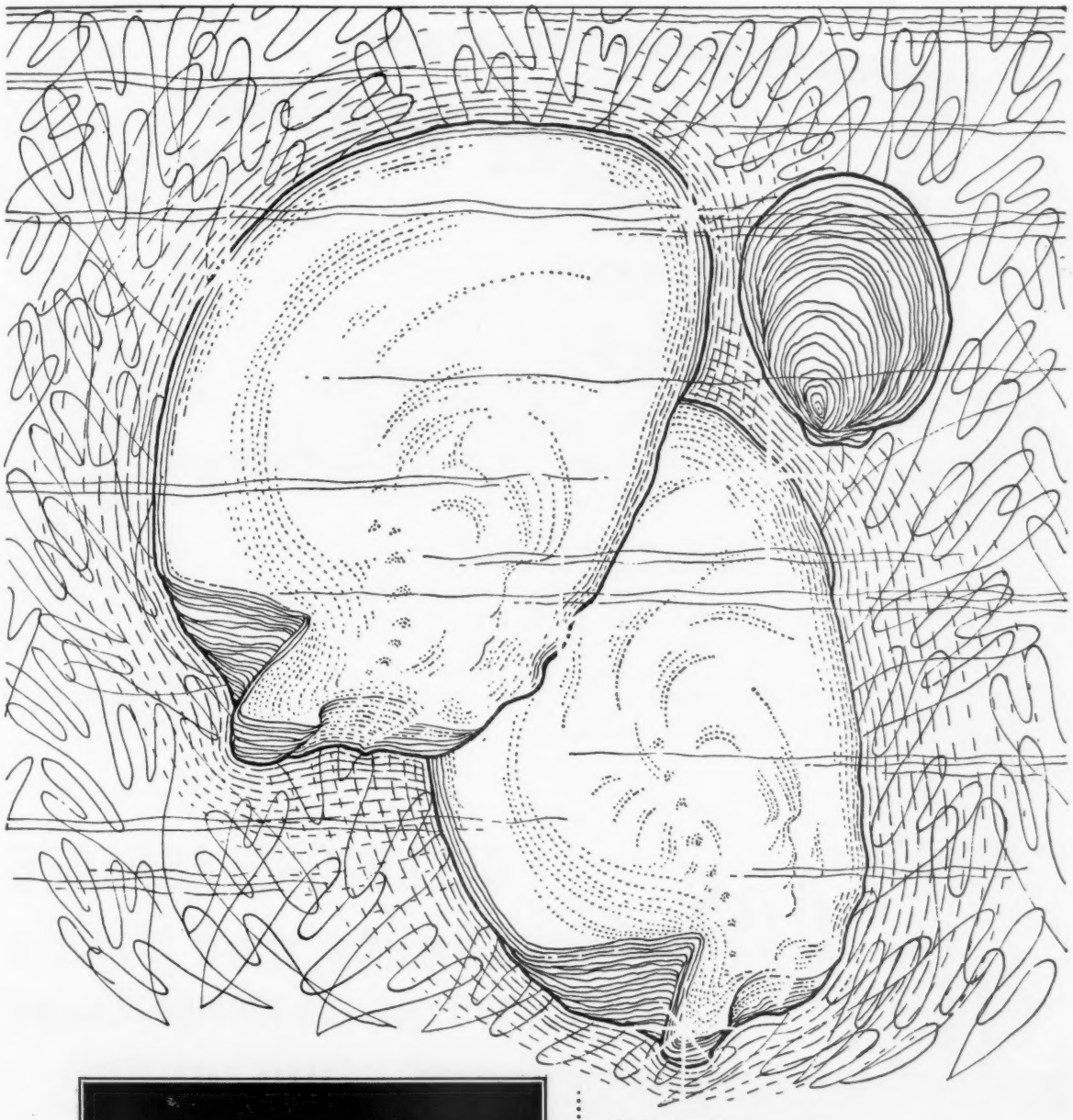

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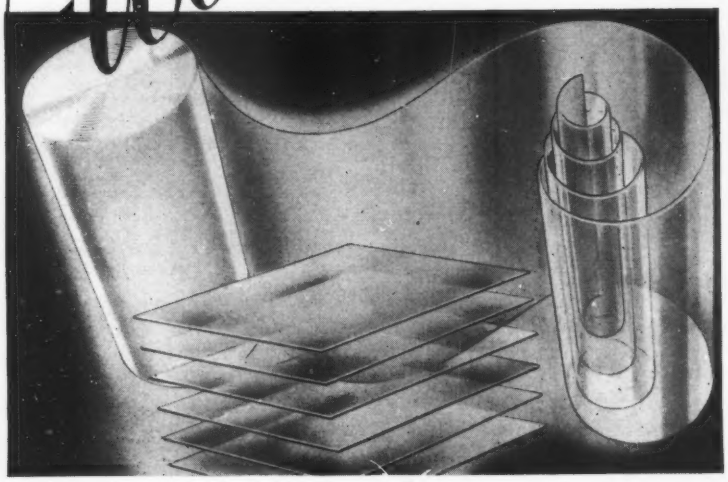

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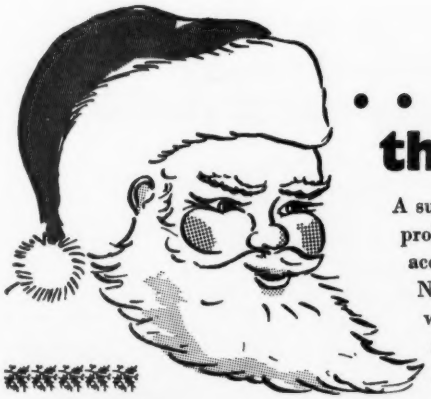

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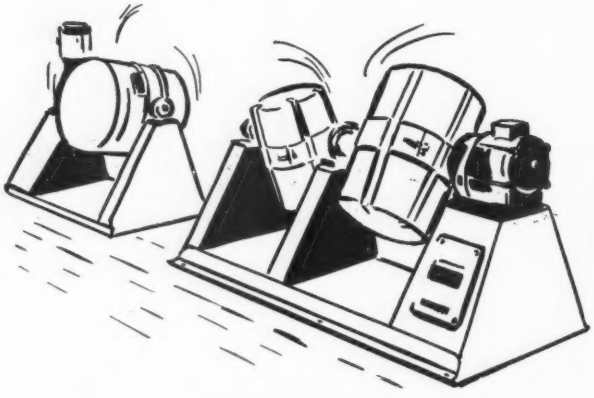

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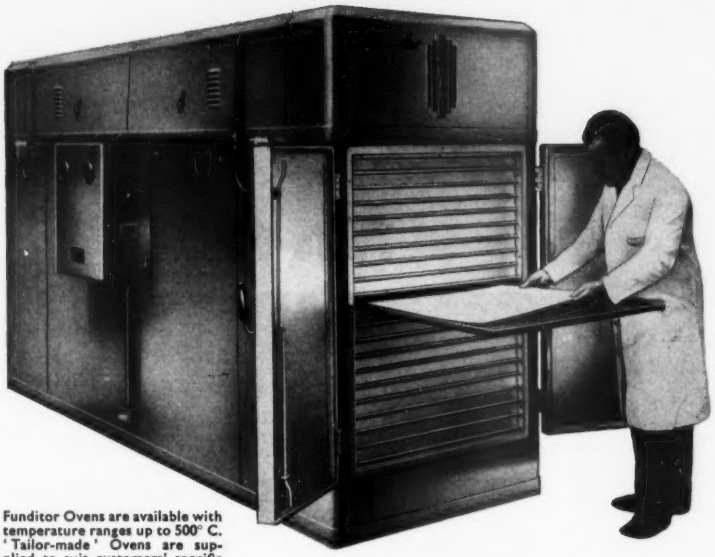

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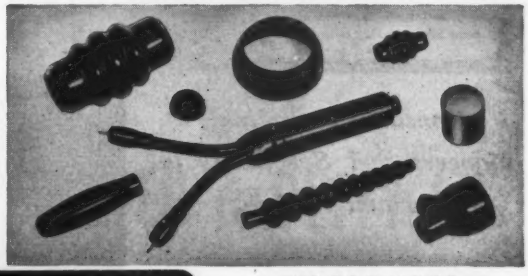

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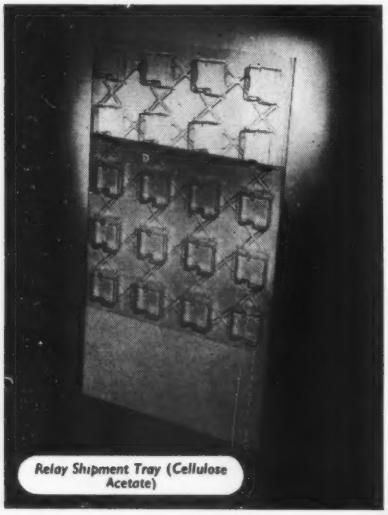

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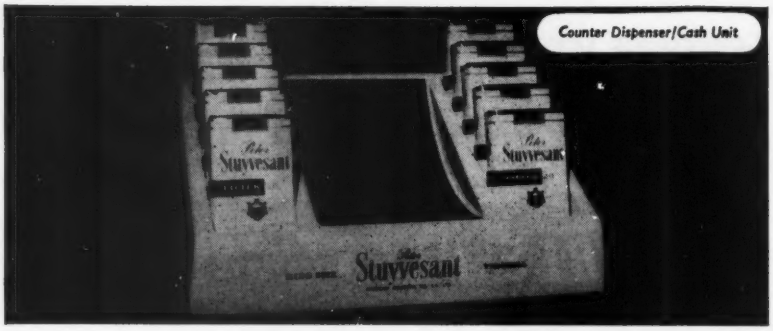

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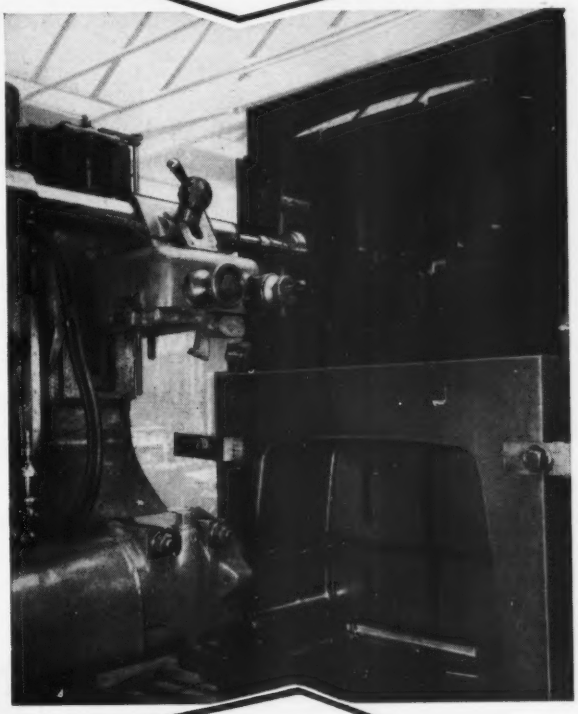

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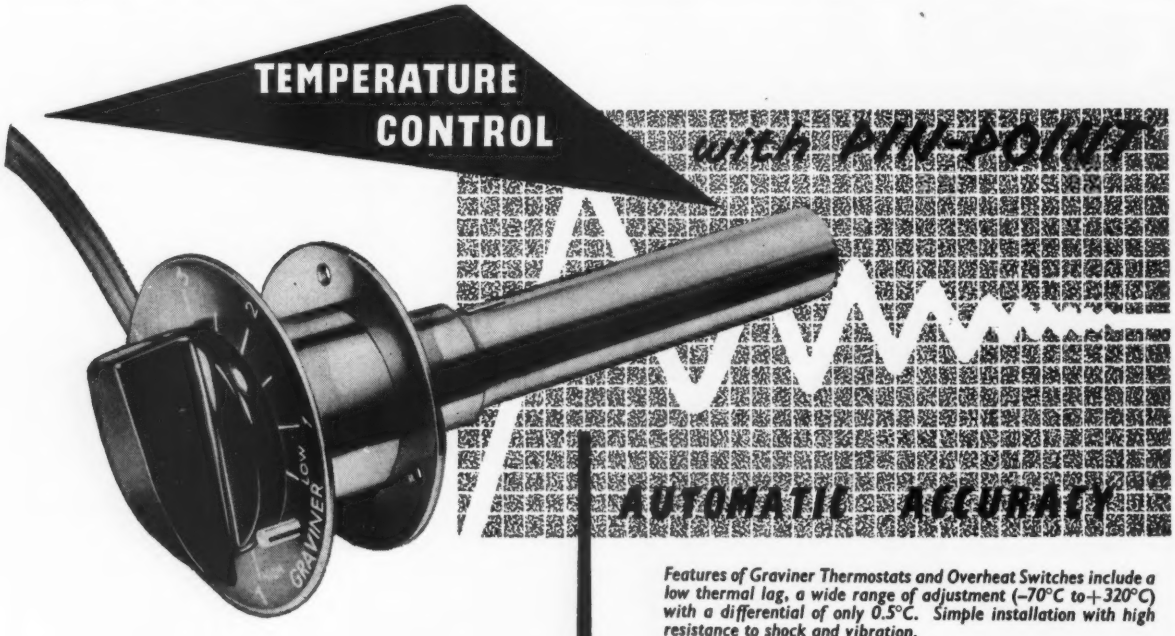

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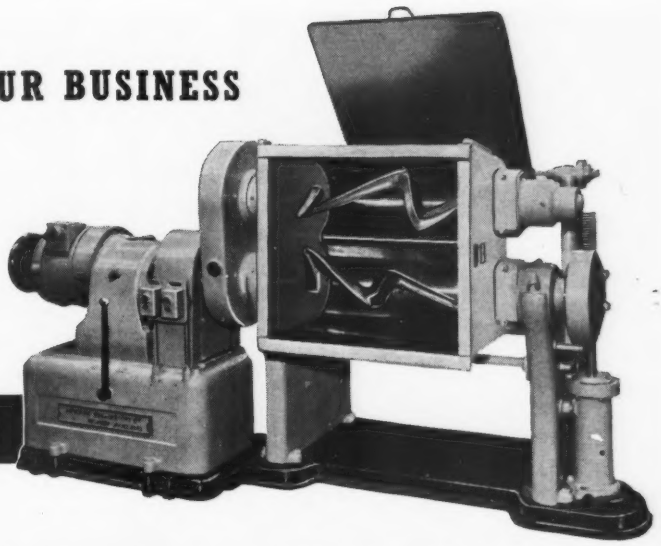

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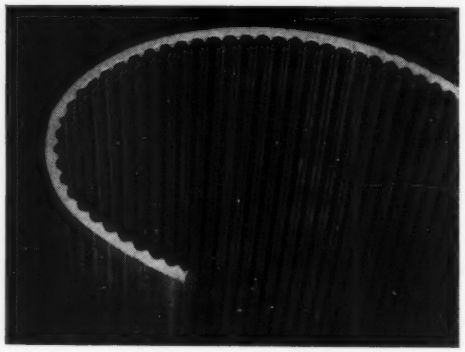

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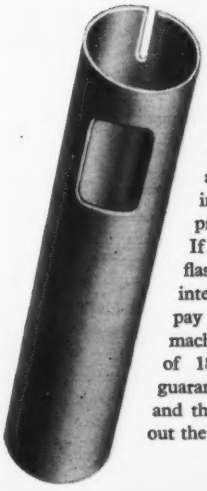

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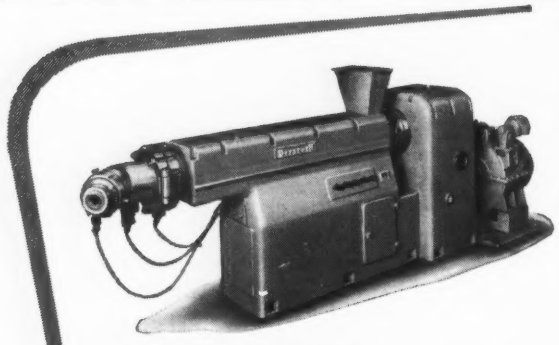

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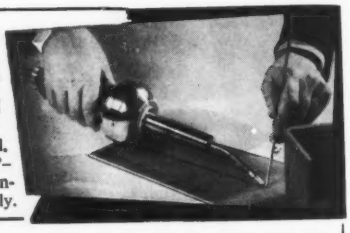

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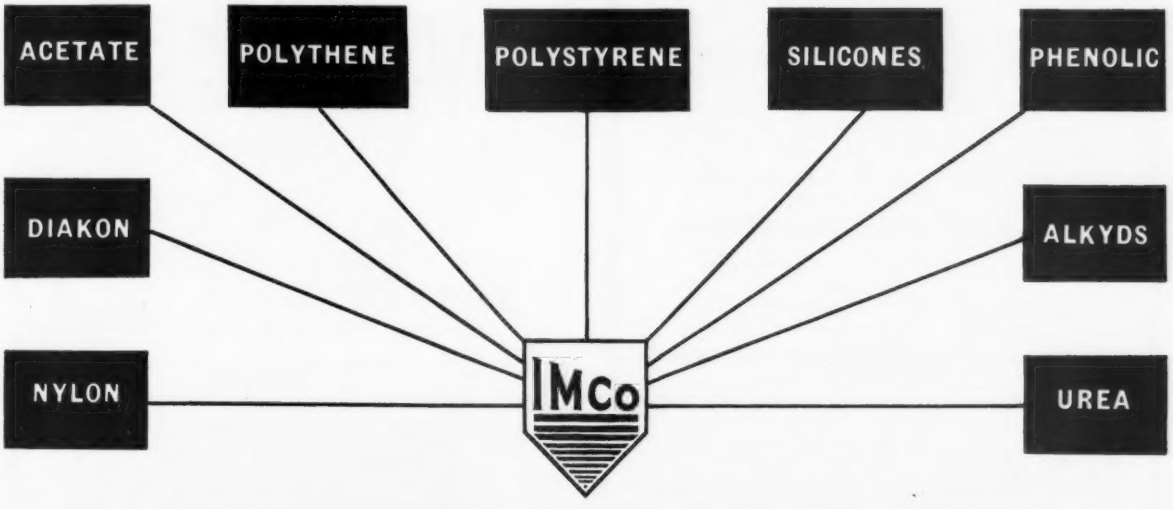

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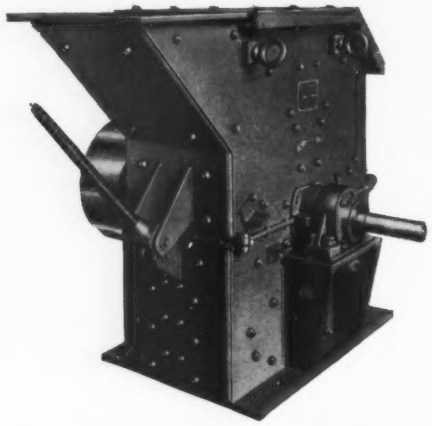

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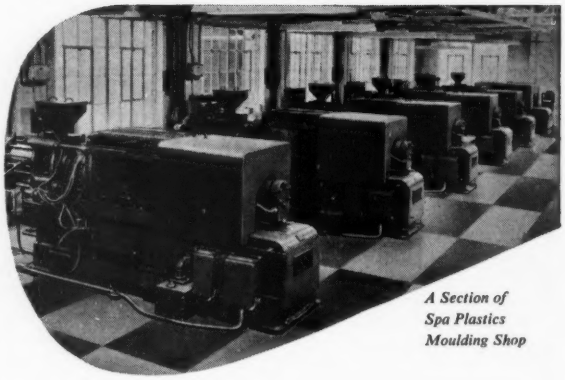

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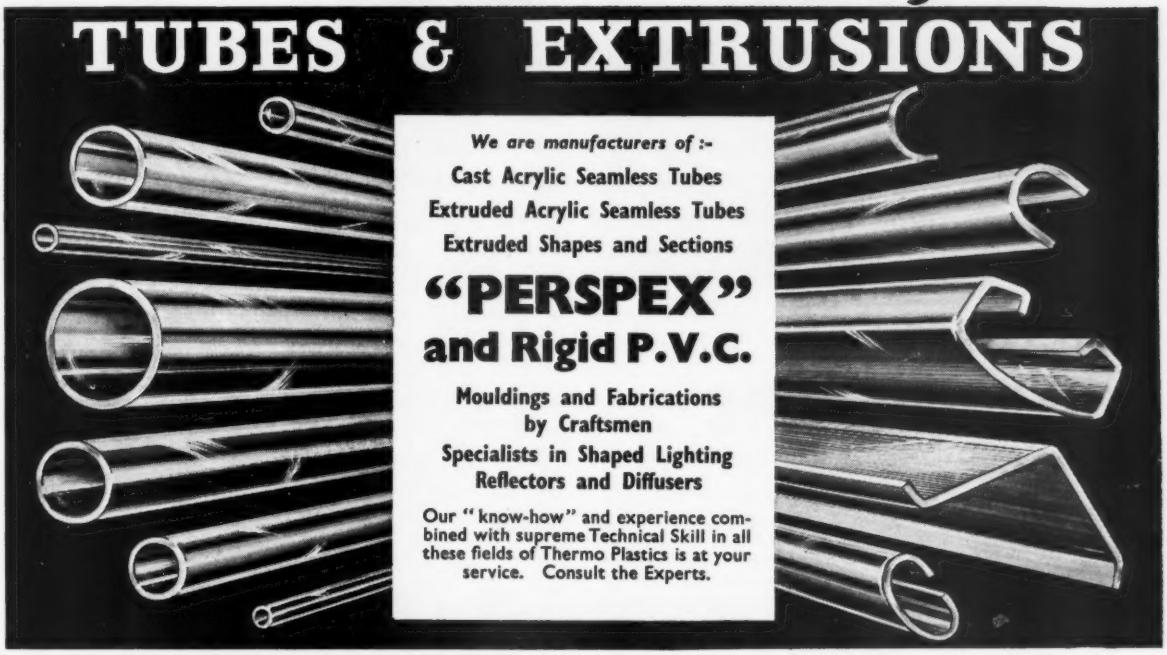

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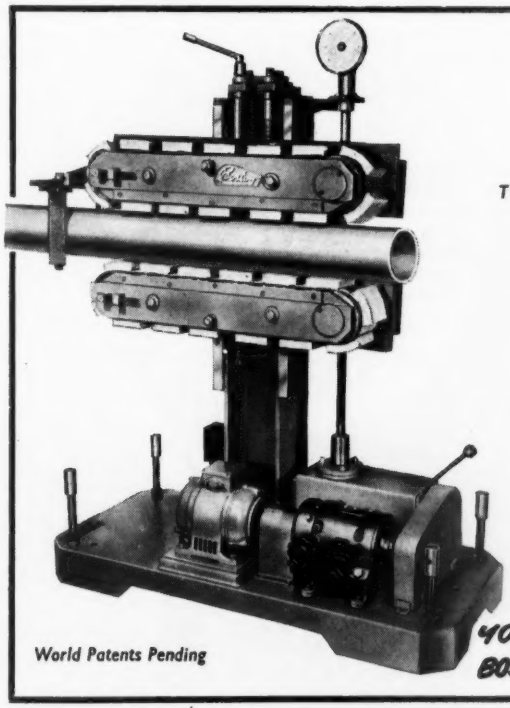

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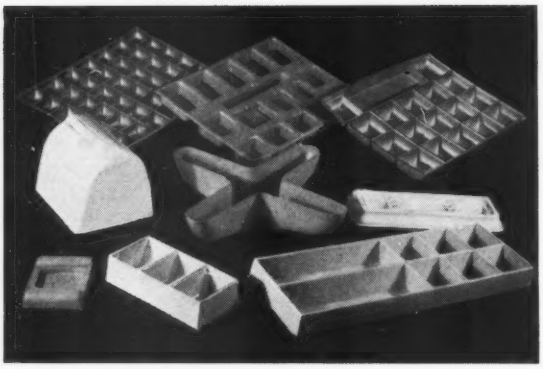

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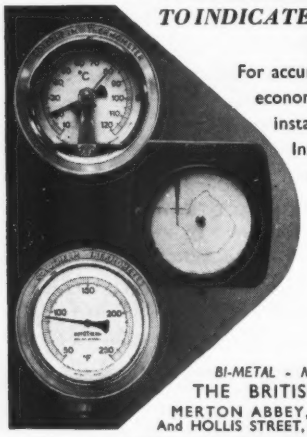

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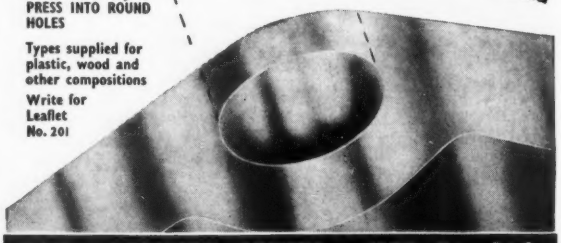

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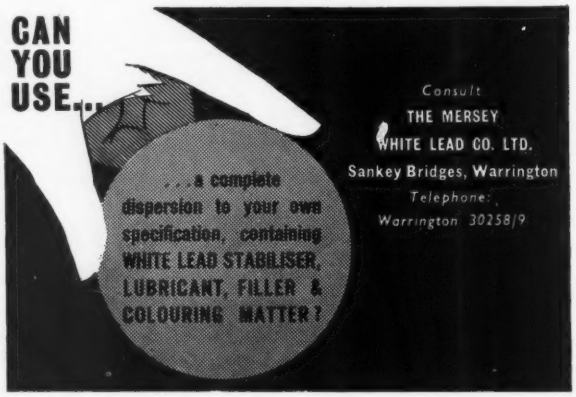

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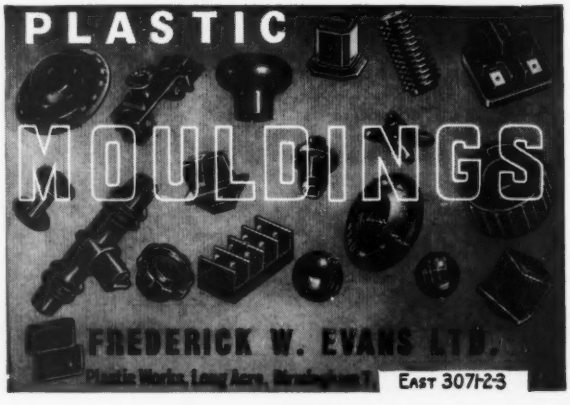

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SPOT CASH BUYERS of all thermoplastic injection scrap and redundant virgin lots. Regular collections. WG Plastics, 14 Cambridge Park Mews, Twickenham, Middlesex. Popesgrove 1800. 258-1305

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WANTED all types of Polythene Scrap. Send details and samples to: Tyruplex Ltd., 111 High St., N.W.10. Elgar 2684. 253-5

Raw Material Wanted (contd.)

MANUFACTURER requires hard-wearing plastic material to stand up to wear and tear, and constant abrasive action on surfaces such as metalled roads, concrete, etc. Box 5414, care of " Plastics." 256-1510

LEEPLAS PRODUCTS require all types of Scrap, P.V.C., Polythene, Polystyrene, etc., in any form. Best prices paid. Details and samples to Carlton Works, Johnson Street, Tyldesley, Nr. Manchester. zzz-197

THERMOPLASTIC SCRAP AND MOULDING POWDERS. We buy large and small quantities and pay prompt Cash. Offers to J. W. Nash & Co., Ltd., 27 Beethoven St., W.10. Ladbroke 4655/6/7. 253-21

ALL TYPES THERMOPLASTIC SCRAP wanted. Quantity immaterial. Send offers and samples to Victor Grant Plastics Ltd., 67 Westbourne Grove, London, W.2. Park 2681–2. zzz-201

POLYTHENE SCRAP. Top prices paid on any terms for any form of polythene scrap, i.e. extrusion lumps, scrap articles, film offcuts, ground and re-ground forms. Please send details and samples to: Herbert Connor Ltd., 120 Beaufort Park, London, N.W.11. 253-3

REFRIGERATION & AIR CONDITIONING PLANT

FRIGIDAIRE LOW TEMPERATURE REFRIGERATORS, 49 in. wide × 28 in. deep × 34 in. high. Ext. Ex large national user, suitable A.C. or D.C. deep freezing, storage of ice-cream, frozen foods, etc. Price £40 each. Domestic refrigerators, service cabinets, and cold rooms also available. A.R.C., 134 Great Portland St., London, W.1. MUSeum 4480. zzz-171

SITUATIONS VACANT

MILL SHOP SUPERVISOR required for London factory. Experienced rubber and plastics compounding and with sufficient chemical background for testing, etc. Must be able to handle labour and production from Banbury mixers on shift work. Age 30/50. Apply with full details, qualifications, previous experience and positions held, to Box No. M5250, Haddon's, Salisbury Square, London, E.C.4. 254-1477

SENIOR LEATHERCLOTH CHEMIST required by Bernard Wardle (Everflex) Ltd. Experience in the coated fabrics field, with particular reference to p.v.c. essential. Applications, giving full details, including salary required, should be addressed to the Managing Director, Peblig Mill, Caernarvon, North Wales. 254-1478

AS A RESULT OF EXPANSION, Tenaplas have the following vacancies:
Foreman for shaping and vacuum forming shop. Only men with wide experience in the forming of perspex, p.v.c. and polystyrene need apply.
Tool Design Draughtsman required, preferably with experience on extrusion dies but all round knowledge of die and mould design acceptable.
Foreman for expanding tool room, must have wide experience and already holding a job of similar calibre.

UPPER BASILDON, NR. PANGBOURNE,
BERKS. 255-1480

EXPERIENCED ESTIMATOR required by Rapidly Expanding Plastics Moulders in the Birmingham area. The Company is engaged on Precision Technical work in both Thermosetting and Thermoplastics materials. The position is permanent and pensionable and offers excellent prospects to the right man who must be capable of assuming responsibility. Please give full particulars of experience and salary required to Box P5423, care of " Plastics." 254-14

EXCEPTIONAL OPPORTUNITY for an Experienced Technical Sales Representative to join a Rapidly Expanding Company Moulding Precision Plastics in a Modern Factory near Birmingham. The applicant should be 30-40 years of age and have a good connection in the Northern Counties. The position is permanent and pensionable and a car will be provided. Remuneration by Salary and Expenses. Give full particulars in the first instance to Box P5422, care of " Plastics." 254-13

WELL KNOWN Injection Moulders of Plastics require Executive capable of developing sales in contract side of business. Must be on friendly terms with buyers of leading firms in industries using injection mouldings in large quantities. Must be experienced in negotiating Contracts at director level. Good salary and commission will be paid to the right man. Write full details previous experience and present salary to Box P5420, care of " Plastics." 254-15

CHARGE HAND required by Injection Moulders (well known trade moulders) in N.W. London, for night shift in their Press Shop. Varied, interesting work. Good progressive position for keen man. Write giving experience, age and salary required to Box P5418, care of " Plastics." 254-16

COMPRESSION MOULDING SHOP FOREMAN required. Near London. Write stating full details of experience. Box P5313, care of " Plastics." 256-1481

TECHNICAL SERVICE and Development Laboratories of an expanding Company require young man for work involving a range of products including thermoplastic extrusion and reinforced plastics. Applicants should be essentially practical and experience in these fields is preferable but not essential. Salary commensurate with qualifications, age and experience. Write relevant details to Box P545, care of " Plastics." 254-x1857

FOREMAN required for expanding Injection Moulders near London. Write stating full particulars. Box P5434, care of " Plastics." 257-1516

Situations Vacant (contd.)

CHEMICAL ENGINEER

or

CHEMIST/TECHNOLOGIST

required by

RUBBER–PLASTICS COMPANY

to work in London on development of GLASS FIBRE REINFORCED RESIN products for industrial and chemical engineering uses. Salary commensurate with qualifications and experience, excellent prospects.

Applications, giving tabulated details of education, experience, age, etc., will be confidential, and acknowledged by Box P5417, care of " Plastics." 254-17

SENIOR LABORATORY ASSISTANT required for research and development work with progressive plastics manufacturing concern in Midlands. Knowledge of compounding and processing (sheeting, extruding, calendering, etc.) essential. Assistance in moving and with housing may be considered for the right man. Excellent prospects. Apply in writing, stating age, experience and salary required to Box P5411, care of " Plastics." 254-19

SENIOR LABORATORY ASSISTANT required for research and development work with progressive rubber manufacturing concern in Midlands. Knowledge of compounding and processing essential. Assistance in moving and with housing may be considered for the right man. Excellent prospects. Apply in writing, stating age, experience and salary required, to Box P5410, care of " Plastics." 254-20

EXPERIENCED INJECTION MOULDING FOREMAN required for Plastics Shop in Romford area. Only man used to producing high quality mouldings need apply. Write giving details of experience, salary, etc., to Box 5413, care of " Plastics." 254-21

TRAVELLER wanted to work as Buyer and Seller of Plastic Scrap and Raw Materials, excellent opportunity for the right man. No age limit. Apply Box P547, care of " Plastics." 254-24

DECORATIVE PLASTIC SHEET SALESMAN required with good contacts particularly in Furniture and Shopfitting. Reply giving experience, age and salary required to Box P546, care of " Plastics." 254-25

TELCON

have a vacancy for a

PLASTICS TECHNOLOGIST

in their Research Laboratories. Duties will include development and evaluation of new compounds in Polythene, P.V.C. and Rubber. Preference will be given to a candidate with H.N.C. or an equivalent qualification. Salary in accordance with qualifications and experience. Please send full particulars (including present salary) to Staff Officer, The Telegraph Construction & Maintenance Co., Ltd., Greenwich, S.E.10 All applications will be treated in strict confidence. 254-29

SENIOR LEATHERCLOTH CHEMIST required by Bernard Wardle (Everflex) Limited. Experience in the coated fabrics field with particular reference to P.V.C. essential. Applications, giving full details including salary required, should be addressed to the Managing Director, Peblig Mill, Caernarvon, North Wales. 255-1515

Situations Vacant (contd.)

SENIOR TECHNICIAN. Ecko Plastics Ltd., Southend-on-Sea, have a vacancy in their Development and Engineering Department for a Plastics Technician for materials and process evaluation. Applicants must be of H.N.C. standard and should have a sound knowledge of materials, tool design and moulding techniques. Write stating age, qualifications, experience and salary required to Personnel Manager. 254-35

PLASTICS TECHNOLOGIST.

The CAPE ASBESTOS CO., LTD., have a vacancy for a PLASTICS TECHNOLOGIST for their Central Laboratory at Barking, Essex. This is a new post and will entail work on methods of preparation and physical properties of reinforced plastics structures made from asbestos and thermosetting resins. Some previous laboratory experience of processing and testing plastics materials is desirable.

An attractive salary will be offered depending upon qualifications and experience, and conditions of service including Pension Scheme are good.

Anyone interested should apply in writing to the GROUP PERSONNEL MANAGER, 114 and 116 PARK STREET, LONDON, W.1, giving details of age, qualifications, experience and present salary. 254-34

TECHNOLOGIST with knowledge of both thermoplastics and rubber to take complete charge of technical sales, customer service and development work in an active and expanding company. The remuneration is in keeping with the importance of the position and provides excellent scope for a young man of integrity, enterprise and ambition. Write to the Managing Director, Phoenix Rubber Co., Ltd., 2k Buckingham Avenue, Slough, Bucks. 254-40

BECK KOLLER & CO. (ENGLAND) LTD.

The following vacancy occurs in our Reinforced Plastics

Laboratory:

DEMONSTRATOR

thoroughly conversant with all aspects of hand lay-up operations and hot-press moulding of glass fibre and other reinforcing materials for polyester resins.

Write to the

TECHNICAL DIRECTOR,

BECK KOLLER & CO. (ENGLAND) LTD.,

EDWARDS LANE,

SPEKE, LIVERPOOL, 24,

giving full details of experience and salary required.

254-37

Situations Vacant (contd.)

J. LYONS & CO., LTD., require the services of a young man 23–30 years of age, with knowledge of plastics applicable to industry, to train as an Assistant in their Plastics Advisory Section of the Building Department. The applicant must have a flair for development work. Write stating age, experience and present salary to the Personnel Manager, Works Dept., 143 Hammersmith Rd., W.14. 254-36

ENGINEER (MAIN GRADE)
required by
THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT, WOOLWICH COMMON, S.E.18.

To develop and advise on the use of plastics in the production of electronic and high voltage electro-mechanical equipment; to investigate and develop new production techniques and to design injection mould tools for production.

A recognised apprenticeship and A.M.I.E.E. or Mech.E. required. Familiarity with modern workshop practice is necessary and some knowledge and experience of electronic production. A knowledge of manufacturing methods using Epoxy resins is desirable.

Salary: £1,400–£1,840.
Contributory Superannuation Scheme.

Postcards for applications forms to the SENIOR RECRUITMENT OFFICER at A.W.R.E., ALDERMASTON, BERKS. Please quote ref. A1856/144. 254-38

SITUATIONS WANTED

YOUNG MAN (24) completed N.S. wishes to obtain situation in plastics industry. London S.E. area. Four years in extruded metals. Box P541, care of " Plastics." 254-x2342

PLASTICS TECHNICIAN, aged 45, seeks executive employment with reputable Company. Long and varied experience, at Board level, of the Plastics industry, including development, manufacture, mould and machine design, administration and sales. Box P5415, care of " Plastics." 254-18

INJECTION MOULDER desires change. Present employed on Reid Prentis 10 oz. machines for over two years. Box P543, care of " Plastics." 254 x2261

FIBREGLASS REINFORCED PLASTICS. Young married man at present residing in N.E. England seeks responsible position in S.E. First class knowledge of hand lay-up techniques. Box P5428, care of " Plastics." 254-8

FIRST CLASS SALES REPRESENTATIVE, aged 34, experienced plastics, rubber, technical and specialised selling, seeks first class employer. Box P5433, care of " Plastics." 254-45

EXECUTIVE, 32, extensive overseas commercial experience, intimate knowledge European market Plastics, Synthetic rubber, Metals. Foreign languages: fluent French, Russian, Spanish, good German. Seeks post preferably overseas representation, England or overseas based. Box P5432, care of " Plastics." 254-x2387

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FACTORY TIME RECORDERS. Service rental. Phone, Hop 2239. Time Recorder Supply and Maintenance Co., Ltd., 157–159 Borough High St., S.E.1. 257-1206

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WANTED. Steel and Brass Wood Screws fitted with Plastic Loose Dome Heads. Full details to Conatus Industries Ltd., Halfway Green, Walton on Thames, Surrey. Tel. 1000. 254-30

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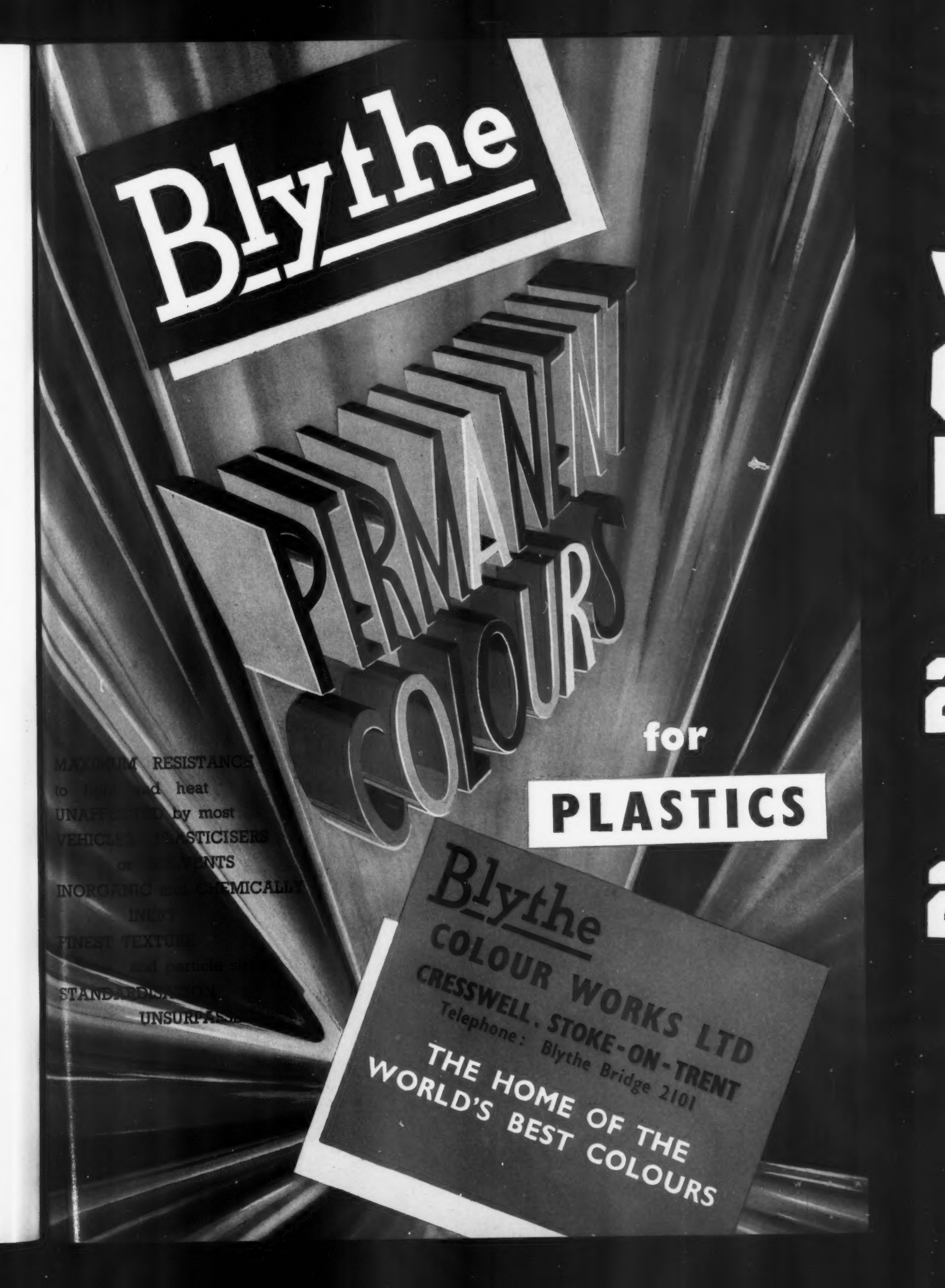
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